The Journal of Parasitology

Volume 2 MARCH, 1916 Number 3

LA FAMILLE DES THELAZIIDAE

A. Railliet, Alfort, Paris

Dans l'importante superfamille des Spiruroidea, on peut dès à présent établir un certain nombre de coupes correspondant à des familles.

C'est ainsi qu'ont été constituées déjà les familles des Spiruridae et des Acuariidae. De même le genre *Tetrameres* Creplin peut être considéré comme le type d'une famille des Tetrameridae; le genre *Hedruris* Nitzsch, celui d'une famille des Hedruridae; les genres *Ancyracanthus* Dies. et *Ancyracanthopsis* Dies. méritent d'être groupés en une famille des Ancyracanthidae, etc.

Il me paraît utile enfin de constituer une famille des Thelaziidae pour les genres du type *Thelazia* Bosc. A côté de ce type viennent en effet se ranger naturellement les genres *Ceratospira* Schneider et *Cystidicola* Fischer, ainsi que deux autres genres nouveaux, *Schistorophus* et *Serticeps*. Et l'on peut même en rapprocher provisoirement le genre *Oxyspirura* Drasche, ainsi que deux autres groupes à créer: *Galeiceps* et *Rhabdochona*.

Famille des THELAZIIDAE.—Spiruroidea. Tête nue ou pourvue, soit d'expansions cuticulaires, soit d'un revêtement en forme de casque. Bouche tantôt sans lévres, tantôt à six petites lévres, parfois à deux seulement, suivie en général d'un vestibule allongé ou d'une courte capsule buccale. Œsophage composé, dans la règle, de deux parties distinctes.

Mâles à queue généralement obtuse, avec ou sans ailes latérales (bourse), portant de chaque côté *une rangée linéaire de nombreuses papilles préanales* parfois couplées; papilles postanales peu nombreuses; 2 spicules presque toujours très inégaux.

Femelles à queue généralement mousse; deux utérus; vulve à situation trés variable. Ovipares ou vivipares.

Habitat.—Région orbitaire des Mammifères et des Oiseaux; tube digestif ou vessie aérienne des Oiseaux ou des Poissons.

Genre type: *Thelazia* Bosc.

Le tableaux ci-après peut servir de clé pour la détermination des genres:

1—Spicules égaux ..... *Galeiceps*
Spicules inégaux 2
2—Bouche pourvue de lèvres ou dents..... 3
Bouche sans lèvres 5
3—Bouche à six petites lèvres papillifères..... *Serticeps*
Bouche à deux lèvres ou dents..... 4
4—Tête ornée de lobes cuticulaires..... *Schistorophus*
Tête nue ..... *Rhabdochona*
5—Mâles à ailes caudales (bourse)..... 6
Mâles sans bourse; courte capsule buccale..... 7
6—Vestibule allongé; papilles préanales couplées..... *Cystidicola*
Courte capsule buccale; papilles préanales simples..... *Ceratospira*
7—Queue obtuse, arrondie; vulve antérieure..... *Thelazia*
Queue pointue, oxyuriforme; vulve postérieure..... *Oxyspirura*

Genre *Thelazia* Bosc, 1819 (*Thelazius* Bosc, 1819; *Thalazia* de Blainville, 1819).—Bouche sans lévres, suivie d'une *capsule buccale;* bord antérieur de la capsule retroussé en dehors et découpé en six festons par des échancrures dont quatre paraissent occupées par un petit organe papilliforme très réfringent. Deux papilles céphaliques latérales et quatre submédianes.

Mâle à *queue obtuse* ordinairement recourbée en crochet, *sans ailes latérales; un grand nombre de papilles préanales* dont une médiane, impaire, au-dessus du cloaque; trois ou quatre (?) papilles postanales. Deux spicules inégaux.

Femelle à *queue* conique *mousse,* arrondie, portant deux papilles latérales â son extrémité. *Vulve située antérieurement,* un peu en arrière de la terminaison de l'oesophage; deux branches utérines dirigées en arrière. Embryons éclosant dans les utérus.

Habitat.—L'habitat normal est représenté par les canaux exréteurs des glandes lacrymales des mammifères, d'où les Vers s'échappent assez souvent pour glisser sous les paupières ou à la surface de l'oeil; on en a signalé exceptionnellement à l'intérieur du globe oculaire. Certaines formes semblent se rencontrer sous la membrane nictitante des Oiseaux.

Espèce type: *Thelazius Rhodesii* Desmarest, 1827.

A.—Espèces des Mammifères.

1.—*Thelazia rhodesi* (Desmarest, 1827).—Syn.: Thélazie de Rhodes Bosc, 1819; *Thelazius Rhodesii* Desmarest, 1827; *Thelazia Rhodesii* de Blainv., 1828; *Filaria bovis* Baillet, 1858; *Filaria palpebrarum* Baillet, 1858; *"Filaria lacrymalis* Gurlt" Baillet, 1866 et Railliet, 1893, pro parte.—Chez le Boeuf (*Bos taurus*) et le Buffle (*Buffelus bubalis*).

2.—*Thelazia gulosa* Railliet et Henry, 1910.—Chez le *Bos taurus.*

3.—*Thelazia alfortensis* Railliet et Henry, 1910.—Chez le *Bos taurus.*

4. *Thelazia leesei* Railliet et Henry, 1910.—Chez le *Camelus dromedarius,* dans l'humeur vitrée, dans un kyste du corps clignotant; commune sous les paupières, principalement sous le corps clignotant et dans le conduit de la glande de Harder.

5.—*Thelazia lacrymalis* (Gurlt, 1831).—Syn.: *Filaria lacrymalis* Gurlt, 1831, pro part e; *Filaria palpebralis* Wilson, 1844, non Pace, 1867; *"Filaria palpebralis* Wilson" Railliet, 1893.—Chez le cheval (*Equus caballus*). Aurait été trouvée par Busch dans l'humeur aqueuse du même animal.

6.—*Thelazia callipaeda* Railliet et Henry, 1910.—Chez le *Canis familiaris.* Paraît commune en Birmanie.

B.—Espèces parasites des Oiseaux.—Ne possèdent pas la papille impaire précloacale.

Thelazia anolabiata (Molin, 1860).—Syn.: *Spiroptera anolabiata* Molin, 1860; *Filaria anolabiata* Stossich, 1897; *Oxyspirura ? anoliabiata* Ransom, 1904.—Chez le *Crax fasciata,* sous la nictitante et à la surface de l'oeil.

Thelazia papillosa (Molin, 1860).—Syn.: *Spiroptera papillosa* Molin, 1860; *Oxyspirura ? papillosa* Ransom, 1904.—Chez *Thrasactus harpyia* et *Geranospizias caerulescens,* sous la nictitante.

Thelazia campanulata (Molin, 1858).—Syn.: *Filaria campanulata* Molin, 1858.—Chez *Rupornis magnirostris,* sous la nictitante.

Thelazia ? cirrura (Leidy, 1886).—Syn.: *Filaria cirrura* Leidy, 1886.—Chez *Megaquiscalus major,* dans l'orbite.

Thelazia ? stereura (Rud., 1819).—Syn.: *Spirotera stereura* Rud., 1819; *Oxyspirura ? stereura* Ransom, 1904.—Chez *Aquila maculata,* sous la nictitante et dans le méat auditif.

Genre *Ceratospira* Schneider, 1866.—Tête nue. Bouche entourée de papilles et suivie d'une courte capsule buccale.

Mâles à queue très courte, mousse, *pourvue de larges ailes;* de chaque côté une rangée longitudinale de papilles simples, dont 9 à II préanales. 2 spicules très inégaux,

Femelles à queue très courte, mousse. Vulve très antérieure. Parfois vivipares.

Habitat.—Cavité orbitaire des Oiseaux.

Espèce type. *C. ve siculosa* Schneider, 1866.

1.—*Ceratospira ve siculosa* Schneider, 1866.—Cavité orbitaire de *l'Eclectus pectoralis.*

2.—*Ceratospira ophthalmica* (Linstow, 1898).—Syn.: *Ancyracanthus ophthalmicus* Linstow, 1898; *Ceratospira ophthalmica* Ransom, 1904.—Cavité orbitaire du *Zonoenas brenchleyi.*

Genre *Schistorophus* n.g. (*Tetracanthus* Hemprich et Ehrenberg, 1866, non Hope, 1835; *Ancyracanthus* Schneider, 1866, pro parte, non Diesing, 1838).—Tête ornée de quatre lobes cuticulaires aigus, confondus en avant avec la cuticule, plus ou moins réunis à leur origine, surtout sur les lignes médianes, et disposés en toit. Bouche petite, généralement à deux petites lèvres ou dents. Un vestibule allongé. Œsophage composé de deux parties.

Mâles à queue mousse, arrondie, pourvue d'ailes latérales et de nombreuses papilles, les préanales disposées de chaque côté en une longue série simple. Deux spicules inégaux.

Femelles à queue courte, conique, plus ou moins obtuse; vulve dans la région postérieure ou moyenne du corps. Parfois vivipares.

Habitat.—Emtre les tuniques du gésier des Oiseaux.

Espèce type: *Ancyracanthus longicornis* Hemprich et Ehrenberg, 1866.

1.—*Schistorophus longicornis* (Hemprich et Ehrenberg, 1866.—Syn.: *Ancyracanthus longicornis* Hemprich et Ehrenberg, 1866.—Entre les tuniques du gésier de *Numenius arquatus, Tringa variabilis, Totanus glottis.*

2.—*Schistorophus bicuspis* (Rud., 1819).—Syn.: *Spiroptera bicuspis* Rud., 1819; *Dispharagus bicuspis.* Duj., 1845; *Histiocephalus gracilis* Dies., 1851; *Histiocephalus bicuspis* Linstow, 1878.—Entre les tuniques du gésier de *Squatarola helvetica.* Probablement identique à la forme précédente.

3.—*Schistorophus bidens* (Rud., 1819).—Syn.: *Spiroptera bidens* Rud., 1819; *Dispharagus bidens* Duj., 1845; *Spiroptera denticulata* Molin, 1860; *Ancyracanthus bidens* Schneider, 1866.—Entre les tuniques du gésier de *Merops apiaster* et peut-être d'*Astur palumbarius.*

4.—*Schistorophus laciniatus* (Molin, 1860).—Syn.: *Histiocephalus laciniatus* Molin, 1860.—Entre les tuniques du gésier de *Rallus cayennensis.*

5.—*Schistorophus* (?) *umbellifer* (Molin, 1860).—Syn.: *Spiroptera umbellifera* Molin, 1860.—Entre les tuniques du gésier *d'ibis rubra* et de *Totanus melanoleucus.*

6.—*Schistorophus* (?) *spinulosus* (Molin, 1860).—Syn.: *Filaria spinulosa* Molin, 1860.—Entre les tuniques du gésier de *Glareola austriaca.*

7.—*Schistorophus* (?) *acanthocephalicus* (Molin, 1860).—Syn.: ? *Strongylus ambiguus* Rud., 1802; ? *Spiroptera Sternae* Rud., 1819; ? *Spiroptera sternae hirundinis* Deslongchamps, 1824; *Spiroptera acanthocephalica* Molin, 1860.—Entre les tuniques du gésier de *Sterna caspica;* peut-être dans l'oesophage de *Sterna hirundo.*

8.—*Schistorophus* (*?*) *capillaris* (Molin, 1860).—Syn.: *Spiroptera capillaris* Molin, 1860; *Cheilospirura capillaris* Diesing, 1861.—Entre les tuniques du gésier de *Sterna hirundo*.

Genre *Serticeps* n.g.—Tête ornée d'appendices ou festons multiples et variés. Bouche à six petites lèvres portant chacune une petite papille.

Mâles à queue obtuse; ailes caudales asymétriques; 10 paires de papilles préanales. Deux spicules très inégaux.

Femelles à queue obtuse. Vulve voisine de l'anus.

Habitat.—Entre les tuniques du gésier des Oiseaux.

Espèce type: *Spiroptera vulvoinflata* Molin, 1860.

1.—*Serticeps vulvoinflatus* (Molin, 1860.)—Syn.: *Spiroptera vulvoinflata* Molin, 1860.—Entre les tuniques du gésier de *Trochilus ochropygus*.

Genre *Cystidicola* Fischer de Waldheim, 1897.—Tête nue. Bouche circulaire suivie d'un vestibule cylindrique. Œsophage très long.

Mâles à queue arrondie à l'extrémité; ailes caudales minces; de chaque côté, *une longue rangée de papilles préanales couplées* et de papilles postanales simples. Deux spicules inégaux.

Femelles à queue droite, mousse. Vulve dans la région moyenne ou antérieure du corps; utérus opposés. Œufs nombreux, à coque épaisse, pourvus, au moins dans le type, de filaments polaires.

Habitat.—Vessie aérienne, plus rarement œsophage, des Poissons d'eau douce.

Espèce type: *Cystidicola farionis* Fischer, 1797.

1.—*Cystidicola farionis* Fischer, 1797.—Syn.: *Fissula cystidicola* Lamarck, 1800; *Ophiostoma cystidicola* Rud., 1801; *Spiroptera cystidicola* Rud., 1819; *Dispharagus cystidicola* Duj., 1845; *Ancyracanthus cystidicola* Schneider, 1866.—Vessie aérienne de *Trutta fario, Tr. trutta, Squalius cephalus;* vessie aérienne et œsophage de *Thymallus vulgaris;* œsophage de *Coregonus oxyrhynchus*.

2.—*Cystidicola impar* (Schneider, 1866).—Syn.: *"Gordius argillaceus L."* Martin, 1771; *Ancyracanthus impar* Schneider, 1866.—Vessie aérienne d'*Osmerus eperlanus, Gasterosteus aculeatus, Trutta fario, Coregonus albula, C. fera, C. lavaretus*.

3.—*Cystidicola* (?) *serrata* (Wright, 1879).—Syn.: *Ancyracanthus serratus* R. Wright, 1879.—Coeur de *Coregonus albus*.

Genre *Galeiceps* n.g.—Tête pourvue d'un renflement qui la coiffe à la façon d'un couvercle ou d'un casque. Bouche à quatre bourrelets séparés sur la surface ventrale et portant chacun à son bord interne une dent conique.

Mâles à queue obtuse; nombreuses papilles préanales simples. Deux *spicules égaux.*

Femelles à queue très courte et pointue.

Habitat.—Intestin des Marsupiaux.

Espèce type: *Ancyracanthus cucullus* Linstow, 1899.

1.—*Galeiceps cucullus* (Linstow, 1899).—Syn.: *Ancyracanthus cucullus* Linstow, 1899.—Intestin de *Potamogale velox.*

Genre *Rhabdochona* n.g.—Tête nue. Bouche à deux lèvres limitant une cavité infundibuliforme soutenue par des bâtonnets longitudinaux. Œsophage de médiocre longueur, composé de deux parties distinctes.

Mâles à queue conique, pointue, recourbée; pas d'ailes caudales; nombreuses papilles préanales et postanales simples. Deux spicules inégaux.

Femelles à queue droite, conique, allongée. Vulve vers le tiers postérieur du corps; utérus opposés.

Habitat.—Intestin des Poissons d'eau douce.

Espèce type: *Dispharagus denudatus* Duj., 1845.

1.—*Rhabdochona denudata* (Duj., 1845).—Syn.: ? *Fusaria cuneiformis* Zeder, 1800; ? *Ascaris cuneiformis* Rud., 1809; *Dispharagus denudatus* Duj., 1845; *Histiocephalus denudatus* Dies., 1851; *Cucullanus pachystomus* Linstow, 1873; ? *Dispharagus filiformis* Zschokke, 1884; *Ancyracanthus denudatus* Linstow, 1887; *Ancyracanthus denudatus* Linstow, 1902.—Intestin de nombreaux Cyprinidés.

Genre *Oxyspirura* Drasche, 1897.—Tête nue, rarement avec un renflement cuticulaire. Bouche sans lèvres, suivie d'une courte capsule buccale. *Queue très aigüe,* oxyuriforme.

Mâles à queue généralement incurvée ou spiralée, dé pourvue d'ailes latérales; papilles non pédonculées, les préanales en nombre assez variable (2 à 28), les postanales (1 à 8) souvent asymétriques. Deux spicules très inégaux.

Femelles à queue droite. Vulvedans la partie postérieure du corps, un peu en avant de l'anus.

Habitat.—Sous la nictitante des Oiseaux.

Espèce type: *Spiroptera cephaloptera* Molin, 1860.

1.—*Oxyspirura cephaloptera* (Molin, 1860).—Syn.: *Spiroptera cephaloptera* Molin, 1860; *Cheilospirura cephaloptera* Diesing, 1861; *Oxyspirura cephaloptera* Stossich, 1897.—Sous la nictitante de *Momotus momata* et d'*Icterus croconotus.*

2.—*Oxyspirura anacanthura* (Molin, 1860).—Syn.: *Spiroptera anacanthura* Molin, 1860; *Oxyspirura anacanthura* Stossich, 1897.—Sous la nictitante de *Crotophaga ani* et *Cr. major.*

3.—*Oxyspirura brevisubulata* (Molin, 1860).—Syn.: *Spiroptera brevisubulata* Molin, 1860; *Oxyspirura brevisubulata* Stossich, 1897.—Sous la nictitante d'*Otus choliba.*

4.—*Oxyspirura mansoni* (Cobbold, 1879).—Syn.: *Filaria Mansoni* Cobbold, 1879, non Zune, 1892; *Spiroptera Emmerezi* Mégnin, 1901; *Spiroptera Mansoni* Marotel, 1903; *Oxyspirura Mansoni* Ransom, 1904.—Sous la nictitante de *Gallus domesticus, Meleagris gallopavo, Pavo cristatus domesticus.*

5.—*Oxyspirura parvovum* G. Sweet, 1910.—Syn.: *Oxyspirura parovum* Breinl., Taylor et Johnston, 1913.—Sous la nictitante et dans la fosse lacrymo-nasale de *Gallus domesticus.*

6.—*Oxyspirura ophthalmica* (Linstow, 1903).—Syn.: *Cheilospirura ophthalmica* Linstow, 1903; *Oxyspirura ophthalmica* Ransom, 1904.—Œil de *Turnix taigoor.*

7.—*Oxyspirura siamensis* (Linstow, 1903).—Syn.: *Cheilospirura siamensis* Linstow, 1903; *Oxyspirura siamensis* Ransom, 1904.—Chez *Centropus sinensis* (probablement oeil).

8. *Oxyspirura anthochoerae* Johnston, 1911.—Syn.: *Ascaris* sp. Krefft, 1873; *Ceratospira anthochoerae* Johnston, 1911; *Oxyspirura anthochoerae* Johnston, 1912.—Œil *Anthochoera caruncalata.*

On a fait en outre rentrer dans ce genre diverses autres formes au sujet desquelles les plus grandes réserves s'imposent, par exemple:

Spiroptera sigmoidea Molin, 1860, cavité orbitaire de *Corvus frugilegus.*

Spiroptera brevipenis Molin, 1860, sous la nictitante de *Cariama cristata.*

Spiroptera heteroclita Molin, 1860, sous la nicitante de *Nothocrax urumutum.*

Spiroptera acuminata Molin, 1860, intestin de *Brycon falcatus.*

Spiroptera spiralis Molin, 1860, sous la plante des pieds des Edentés: *Bradypus cuculliger* et *Choloepus didactylus.*

SEASONAL DISTRIBUTION OF SOME ACANTHOCEPHALA FROM FRESH-WATER HOSTS *

H. J. VanCleave

In a recent paper Linton (1914: 48-56) has given a brief survey of the evidence on seasonal distribution of parasites of marine fishes. He concluded this paper with the statement: "There does not appear to be evidence of any marked periodicity in the occurrence of helminth parasites of marine fishes, either adult in the alimentary canal, or immature encysted in the tissues of their hosts, beyond what may be expected where fishes are exposed to varying sources of infection in the course of their migrations." In speaking of the seasonal distribution of Acanthocephala he has recorded the occurrence of *Echinorhynchus gadi* Müller (which he called *E. acus*) in *Pseudopleuronectes americanus* ". . . in every month in which examinations were made, viz., January, February, April, May, July, August, September, October, November, and December." The mere fact that a parasite is present in its final host for the greater part of, or even for the entire, year is not proof that there is no periodicity in its occurrence. One generation of parasites might overlap another generation, yet if conditions for reinfestation were such that larvae could enter the final host only at restricted periods it would be possible to detect a periodicity in the infestation upon the basis of the distinctions between immature and mature individuals. Unfortunately most records make no mention of age of the parasites. On the other hand, if the intermediate host of the parasite constitutes a part of the food of the final host throughout the year the chances for constant reinfestation make it impossible to recognize distinct cycles of infestation.

Conditions of life in fresh-water are so much more varied than in the ocean that it would not be surprising to find seasonal changes in kinds of parasites and degrees of infestation more marked in hosts from fresh water than in hosts from the ocean. Very little has been done toward establishing any correlation between extent or degree of parasitic infestation and periodicity of occurrence. The records on these topics deal almost exclusively with the general problem of the number of parasites found in a given host without further analysis beyond an occasional tabulation of the data for the classes or orders of the parasites found. A number of writers have recorded the

* Contributions from the Zoological Laboratory of the University of Illinois, No. 58.

months in which they have found Acanthocephala in various hosts without furnishing any data on the presence or absence of the same parasites in the same hosts at other times of the year. Thus Zschokke (1884: 58) has recorded *Pomphorhynchus laevis* (Müller) from various fishes from January to June, but he has not given any evidence or proof of its absence for the remainder of the year. In fact his records seem only to indicate the dates when he chanced to examine fish which were infested with *P. laevis* rather than to represent an attempt on his part to establish the limits of the seasons when this parasite occurs in its final host.

In collecting fresh-water Acanthocephala the writer has been impressed by the varying degrees of infestation of certain hosts at different times of the year. A search of the literature has furnished so little actual information upon this subject that it seemed worth while to investigate the question, especially since Linton has rather summarily dismissed the topic with a brief generalization. The records from which the following data have been gathered comprise three species of Acanthocephala. In one of these no marked seasonal distribution is evident, while in the other two definite seasonal cycles mark the occurrence of the parasite in its final host.

*Neoechinorhynchus** *emydis* (Leidy) occurs in the intestine of a number of fresh-water turtles. The records of the writer and of Mr. H. W. Stunkard include the examination of over 200 individuals belonging to species susceptible to infestation with *N. emydis*. These came from Iowa, Ohio, West Virginia, Texas, and various points in Illinois. The unselected data from all the records when assembled and tabulated presented evidence of a seasonal distribution of *N. emydis*, which upon closer examination of the data proved to be spurious. Parasites of this species were recorded from hosts examined in October, November, December, January, and February with a few records of occurrence in July. Records of examinations in April, June, and September showed no infestation with this parasite. This in itself seemed to indicate a restriction of *N. emydis* in the intestine of its final host to a limited portion of the year. However, further examination revealed that certain localities within the geographical range of the species are free from that parasite. By a strange coincidence turtles happened to be examined from these localities in months when no records were available for regions where *N. emydis* is known to occur. This shows how statistical data if not carefully checked may give false evidence of cyclic occurrence of an organism.

---

* Neoechinorhynchus, Stiles and Hassall, 1905=Eorhynchus, VanC., 1914=Neorhynchus, Hamann, 1892, preoccupied.

Indirect evidence has shown that *N. emydis* occurs in the intestine of its final host throughout the year. Turtles from Havana, Ill., have been kept without food in aquaria fed by the University of Illinois water supply, which is from deep wells, for about eleven months. At the end of this time one turtle still harbored twelve mature specimens of *N. emydis* in its intestine. The evidence of an original infestation lasting practically a year, together with the fact that in many instances the writer has found fully mature, immature, and intermediate specimens in the intestine of the same individual proves that turtles in regions where *N. emydis* occurs are constantly exposed to reinfestation with that species. Consequently there is no cyclic change in the degree of infestation from month to month.

It is interesting to note that while *N. emydis* has a broad geographical distribution, occuring in the records under consideration at certain points in Illinois, North Carolina, and Texas, it is by no means generally distributed over its range. In Illinois, for example, turtles of species susceptible to infestation with *N. emydis* have been collected at Urbana, Muncie, and Chicago, and in no case has a single specimen of *N. emydis* been found. It seems strange that a species with such a broad dispersal should not have followed the dispersal of its final host. This probably finds explanation upon the grounds that in the localities where the parasite does not now occur if it was originally or subsequently introduced the embryos when expelled from the intestine of the final host were not taken up by animals in which the larvae could develop or in case they did find lodging in a host it must have been in some animal which was not used by the turtles as food. Thus through the lack of adaptability to new conditions brought on by the specialization accompanying parasitism this species has been excluded from some regions which are included within its limits of distribution.

In contrast with the lack of periodicity in the species just discussed may be noted the condition found in *Neoechinorhynchus gracilisentis* (VanC.) found in the intestine and intestinal caeca of the gizzard-shad, *Dorosoma cepedianum* (LeSueur), from the Illinois River system. During the period from 1909 to 1912 the writer examined more than 300 gizzard-shad for parasites. But two species of parasites have been found. Both of these were Acanthocephala belonging to the genus Neoechinorhynchus. *N. gracilisentis* has been found in October, November, December, February, March, and April, but specimens at these different dates displayed wide variation in degree of sexual maturity. Those collected in October were almost invariably small and immature, with a high percentage of infestation. By the latter part of November individuals of this species had reached full sexual maturity, as indicated by the numbers of hard-shelled embryos contained in the body cavities of the females. In April the percentage

of infestation had decreased to less than one half of that found for October, and the number of individuals per host also had decreased though every parasite had reached full sexual maturity and the maximum size for the species. Numerous examinations in the months of June, July, and August have failed to give even a single specimen of this species. From the foregoing data it is evident that the introduction of *N. gracilisentis* into the final host must occur in early fall, probably in September. The individuals have become fully mature by April and disappear entirely from the final host during the months of June, July, and August. In an earlier paper (VanCleave 1913; 181) I have indicated the probable relationship between this periodicity of infestation and the food habits of the gizzard-shad. Observations upon the stomach contents of the shad, which is primarily a scavenger, have failed to throw any light upon the probable intermediate host of this parasite. The entire digestive tract is usually filled with mud and decomposed plant tissues with a very few shelled rhizopods and some species of microcrustacea.

TABLE SHOWING SEASONAL DISTRIBUTION OF THREE FRESH-WATER SPECIES OF NEOECHINORHYNCHUS

Species	January	February	March	April	May	June	July	August	September	October	November	December
N. emydis*.....	+	+	X	X	X	X	+	X	X	+	+	+
N. gracilisentis.....	X	+	+	+	±	—	—	—	±	+	+	+
N. longirostris.....	—	—	—	—	±	+	+	+	X	X	+	+

* For additional experimental evidence see text.
\+ Positive records of occurrence based upon examination of hosts.
— Absence from all hosts examined.
± Extremely probable occurrence. Though definite records of infestation are wanting the stage of maturity of individuals collected the preceding or the following month indicates that a complete gradation of stages in development necessitates an overlapping of infestation into adjacent month.
X records, both positive and negative, wanting though stages of maturity of the parasites in the two adjacent months together with the data upon longevity of the species in the final host justifies the assumption of a positive infestation.

Neoechinorhynchus longirostris (VanC.), the second species found in the intestine and intestinal caeca of the shad, occurs in much smaller numbers and in but a very small percentage of fishes examined. Immature individuals were found in June and July. Gravid females were found in August, November, and December. While the number of records is insufficient to permit of establishing all points in a seasonal cycle, yet the evidence at hand indicates that the host is free from parasites of this species from late winter until early summer.

In the case of both species of Neoechinorhynchus from the gizzard-shad the relatively short life in the body of the final host is noticeable.

Moreover, the parasites of a given species collected at the same time from a given region have all reached approximately the same stage in development. This indicates that the period when infestation may occur is very brief. Attention should also be called to the fact that periods of infestation in these two species are not coexistent.

CONCLUSIONS

1. Seasonal distribution of fresh-water Acanthocephala varies in different species. No general statement can be made to apply to the entire group.

2. *Neoechinorhynchus emydis* (Leidy) has broad limits of geographical distribution, but has never been found in turtles of susceptible species from some localities within its range of distribution.

3. *N. emydis* occurs in turtles from some localities at all seasons of the year.

4. The same host may harbor specimens of *N. emydis* in all stages of development between immature and fully mature. This shows the host must be exposed constantly to sources of infestation.

5. There is no cyclic change in the degree of infestation with this species from month to month.

6. *N. gracilisentis* (VanC.) enters the gizzard-shad in early fall, probably September; in April or May it attains sexual maturity and is finally expelled. During the summer the gizzard-shad is not parasitized by this species.

7. *N. longirostris* (Van.C.) parasitizes the gizzard-shad in the summer, reaches full sexual maturity by midwinter, and disappears entirely from spring to early summer.

8. The demonstrable presence of a seasonal cycle in the life history of a parasite involving two or more hosts is dependent upon (*a*) longevity of the parasite in the final host; (*b*) extent of the time in which infestation of the final host may occur; (*c*) length of time required for development of the larva in the intermediate host; (*d*) seasonal changes in the food habits of the final host, or active migrations of the host to and from sources of infestation.

Literature Cited

Linton, Edwin. 1914. On the Seasonal Distribution of Fish Parasites. Tr. Amer. Fish. Soc., 44: 48-56.

Stiles, C. W., and Hassall, A. 1905. The Determination of Generic Types, and a List of Roundworm Genera, with Their Original and Type Species. Bull. Bur. An. Ind., 79: 150 pp.

VanCleave, H. J. 1913. The Genus Neorhynchus in North America. Zool. Anz., 43: 177-190.

Zschokke, Fr. 1884. Recherches sur l'organisation et la distribution zoologique des vers parasites des poissons d'eau douce. Thesis Genève; 89 pp.

ON THE INTERMEDIATE HOSTS OF THE LUNG DISTOME, *P. WESTERMANI* KERBERT

SADAO YOSHIDA
Pathological Department of Osaka Medical University

Japan is famous for being considerably infested with lung distome. It is about thirty-four years since the human lung distome was discovered by Kiyono, Yamagata, Nakahama, and Suga in Okayama prefecture, near the center of the country. During these years though numerous reports on symptoms of patients and on diagnosis and many pathological notes have been published by investigators from various districts of the country, the result of the developmental investigations has not yet been achieved, nothing being known of a life history of the parasite. Fortunately, however, light has been thrown upon the subject by the recent discovery of an intermediate, probably the second, host of this worm by Koan Nakagawa, director of the Shinchiku Hospital, Formosa, who has been earnestly investigating this parasite in Formosa for several years.

I have also studied experimentally the life-history of this worm, and found certain species of fresh water crabs as intermediate hosts. I shall here communicate the results obtained from my experiments.

INTERMEDIATE HOST

In Formosa Nakagawa found the encysted larvae in two fresh water crabs and experimentally proved that they grew up to the lung distomes. The two crabs were identified by A. Terao as follows: *Potamon* (*Geothelphusa*) *obtusipes* (Stimpson), *P.* (*Ge.*) *dehaanii* (White).

Nakagawa added that a fresh-water crab *Eriocheir japonicus* (De Haan) will also probably prove to be the intermediate host.

I have experimentally proved that the encysted larvae of this worm are found in three species of fresh-water crabs from various districts of Japan proper. They are identified as follows: 1. *Patamon dehaanii* (White); 2. *Sesarma dehaani* (Milne Edwards); 3. *Eriocheir japonicus* (De Haan).

These species can be found in any part of Japan. *P. dehaanii* is small in size and light reddish brown or purple in color. It is a common crab in the shallow water of a mountain stream. This crab is edible and used for food commonly in some districts and rarely in other parts of this county. It can be eaten raw or cooked. *E. japan-*

icus is large in size and dark brown or black in color, very common in any brook and river of Japan, including Formosa and Corea. Large hairy forceps are characteristic of this species. It also is edible and commonly used for food in all districts, though generally eaten cooked being roasted, boiled, or fried. *S. dehaani* is of median size, the same in color as *E. japonicus,* having light reddish purple forceps. It lives generally in the lower parts of a river in various parts of our country. This species is not used for food.

Distribution of Encysted Larvae in Body of Intermediate Hosts.—The encysted larvae occur generally in the liver, muscles, and gills of the host. The distribution of the encysted larvae varies but slightly according to the species of the host, so far as I have examined. In *P. dehaanii* and *P. obtusipes,* they are found frequently in the liver, and rarely in muscles and gills; in *E. japonicus* chiefly in gills, muscles, and hypodermis, and rarely in the liver; and in *S. dehaani* mainly in the liver and very rarely in the gills. In the liver the encysted larvae are attached loosely to the lobes of the organ so that they may be easily detached. In the gills they adhere between the lamellae in the case of *P. dehaanii,* but are found only in the blood vessel running through the median line of the upper surface of the gill in the case of *japonicus.* In the latter species they occur not only in the muscles of the trunk, but in muscle and hypodermis of all appendages. The encysted larvae in the muscles and hypodermis or in the blood vessels are easily movable.

Frequency of Occurrence and Number of Encysted Larvae in Host.—It is reported by Nakagawa that about 100 per cent. of *P. obtusipes* are infected with the encysted larvae at Shinchiku, the most famous district for the lung distome in Formosa. Ryo Ando reported that about 40 to 70 per cent. of *P. dehaanii* of Gifu prefecture are infected with the larvae. According to my own examination *E. japonicus* of Tokushima and Okayama prefectures is infected to the extent of about 70 to 85 per cent., and *S. dehaani* of Osaka prefecture to about 20 to 80 per cent. The number of the cysts in one crab varies considerably according to species of the host, and even in the same species it varies according to locality and other conditions. In my own examinations I found some *E. japonicus* infected with several hundreds of the encysted larvae while others were infected only with a few in spite of the locality being the same. *S. dehaani* was generally infected with 2 to 30 cysts of the larvae. In *P. dehaanii* from Okayama and Nigigsta prefectures I found only a few cysts while Ando is reported to have obtained several hundreds of cysts in the same species from Gifu prefecture.

I give here tables showing the percentages of the infected crabs and the numbers of the cysts in the hosts examined by myself.

TABLE 1.—*S. DEHAANI* FROM HIEJIMA, OSAKA PREFECTURE

Date	Number of Crabs Examined	Number of Crabs Infected with Cysts	Percentage of Infected Crabs	Maximum of Cysts in One Crab	Minimum of Cysts in One Crab	Total Number of Cysts in Crabs Infected	Average Number of Cysts in One Crab	Number
10/VI	19	4	21.05%	3	1	7	1.43	1
11/VI	8	2	25.00%	2	2	4	2.00	2
12/VI	3	1	33.33%	2	2	2	2.00	3
14/VI	20	2	10.00%	2	1	3	1.50	4
15/VI	12	2	16.66%	3	1	4	2.00	5
16/VI	12	1	8.33%	1	1	1	1.00	6
17/VI	21	5	23.80%	2	1	6	1.20	7
18/VI	8	3	37.50%	4	1	7	2.33	8
22/VI	24	2	8.33%	2	1	3	1.50	9
28/VI	9	2	22.22%	3	2	5	2.50	10
10/VII	10	2	20.00%	8	2	10	5.00	11
11/VII	9	2	22.22%	7	3	10	5.00	12
12/VII	1	1	100.00%	1	1	1	1.00	13
13/VII	11	3	27.27%	3	1	6	2.00	14
14/VII	9	4	44.44%	4	1	10	2.50	15
15/VII	16	2	12.50%	2	1	3	1.50	16
16/VII	8	2	25.00%	3	2	5	2.50	17
	200	40	20.00%	8	1	87	2.17	17

TABLE 2.—*S. DEHAANI* FROM EBIE, OZAKA PREFECTURE

Date	Number of Crabs Examined	Number of Crabs Infected with Cysts	Percentage of Infected Crabs	Maximum of Cysts in One Crab	Minimum of Cysts in One Crab	Total Number of Cysts in Crabs Infected	Average Number of Cysts in One Crab	Number
28/VIII	5	4	80.0%	29	9	89	22.5	1
30/VIII	2	2	100.0%	26	26	52	26.0	2
1/IX	6	5	83.3%	30	15	107	21.4	3
2/IX	5	5	100.0%	22	1	49	9.8	4
	18	16	88.8%	30	1	297	18.5	4

TABLE 3.—*E. JAPONICUS* FROM IKUINA, TOKUSHIMA PREFECTURE

Date	Number of Crabs Examined	Number of Crabs Infected with Cysts	Percentage of Infected Crabs	Maximum of Cysts in One Crab	Minimum of Cysts in One Crab	Total Number of Cysts in Crabs Infected	Average Number of Cysts in One Crab	Number
23/VII	10	9	90 %	19	3	96	10.66	1
25/VII	4	4	100 %	26	1	56	14.00	2
26/VII	7	7	100 %	14	1	29	4.14	3
27/VII	15	13	86.6%	12	1	61	4.69	4
28/VII	1	1	100 %	86	86	86	86.00	5
2/VIII	10	3	33.3%	77	7	161	59.66	6
3/VIII	15	7	46.6%	40	1	70	10.00	7
3/VIII	5	3	60.0%	..	..	..	.....	8
6/VIII	8	6	75 %	48	2	85	14.16	9
7/VIII	2	1	50 %	343	343	343	343.00	10
	77	54	70.1%	343	1	987	19.35	10

TABLE 4.—DISTRIBUTION OF CYSTS IN THE BODY OF NO. 10 IN TABLE 3

Gills on both sides	81
Body muscles on left side	99
Body muscles on right side	109
Forceps on right side	19
Third leg on right side	12
Third leg on left side	23

TABLE 5.—DISTRIBUTION OF CYSTS IN THE LEGS OF THE CRAB IN THE PRECEDING TABLE

	Ischiopodite Meropodite	Carpop-odite	Propo-dite	Dactylop-odite	Total
Right forceps	4	12	3	0	19
Right third leg	7	3	2	0	12
Left third leg	13	6	4	0	23
Total	24	21	9	0	54

TABLE 6.—NINE CYSTS IN GILLS, FIFTY-FIVE IN MUSCLES AND HYPODERMIS

	First Legs (Forceps)		Second Legs		Third Legs		Fourth Legs		Fifth Legs	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Muscles attached	1	2	2	1	6	4	0	2	1	1
Basipodite	1	0	2	1	0	1	0	1	0	0
Ischiopodite	1	3	0	2	0	2	1	0	0	2
Meropodite	4	3	0	0	2	0	0	2	1	1
Carpopodite	0	1	0	0	0	1	2	1	0	0
Propodite	0	0	0	0	0	0	0	0	0	0
Dactylopodite	0	0	0	0	0	0	0	0	0	0
Total	7	9	4	4	8	8	3	6	2	4

TABLE 7.—DISTRIBUTION OF CYSTS IN *E. JAPONICUS* FROM TOMIOKA, TOKUSHIMA PREFECTURE

Number	Total Number of Cysts	Cysts in Gills	Cysts in Muscles, etc.	Number	Total Number of Cysts	Cysts in Gills	Cysts in Muscles, etc.
1	7	7	...	16	106	106	...
2	5	5	...	17	...	...	...
3	5	5	...	18	...	...	...
4	98	31	64*	19	...	...	...
5	193	69	124	20	21	21	...
6	159	67	92	21	11	11	...
7	40	8	32	22	36	36	...
8	2	2	..	23	48	48	...
9	161	40	121	24	16	16	...
10	90	20	70	25	22	22	...
11	3	3	..	26	..	..	...
12	11	11	..	27	35	35	...
13	76	24	52	28	12	12	...
14	51	33	18	29	53	53	...
15	17	17	...	30	390	133	257

* Three in liver.

TABLE 8.—FROM THE ABOVE TABLE

Number of crabs examined	30
Number of crabs infected with cysts	26
Percentage of infected crabs	86.6%
Total number of cysts	1,668
Average number of cysts in one crab	64.1

TABLE 9.—DISTRIBUTION OF CYSTS IN THE MUSCLES AND THE HYPODERMIS OF ONE *E. JAPONICUS* HAVING 390 CYSTS IN ALL (NO. 30 OF TABLE 7)

	First Leg (Forceps)	Second Leg	Third Leg	Fourth Leg	Fifth Leg	Total
Body muscles attached to	49	28	28	9	12	126
Ischiopodite	..	4	0	2	0	6
Meropodite	10	11	16	16	22	75
Carpopodite	10	3	9	6	0	28
Propodite	9	2	6	3	2	22
Dactylopodite	0	0	0	0	0	0
Total	78	48	59	36	36	257

Morphology of the Encysted Larvae.—The encysted larvae found in the above named crabs are almost spherical or rarely elliptical in shape, measuring from 0.25 to 0.55 mm. in diameter. The fully grown cysts vary between 0.30 and 0.55 mm. The wall of the cyst is a transparent chitinous membrane of tolerable thickness. In the fully developed larva in a cyst one may easily and distinctly recognize the organs, for example, both oral and ventral suckers, and alimentary tract including pharynx, esophagus, intestinal coeca, and excretory vesicle. The oral and ventral suckers are of nearly equal size, the former is distinctly visible when the worm is moving and the latter becomes somewhat indistinct on account of being obstructed by an extension of the excretory vesicle. The pharynx is small, the esophagus short and the intestinal coeca run posteriad in a strongly winding course along both sides of body, ending blindly at or near the posterior end. The excretory vesicle occupies nearly all the space between the intestinal coeca.

The parenchymous tissue of the body is tinged with light red pigment so that a cyst containing a larva is easily recognizable even in liver or in muscle. This pigmentation is very convenient in searching for the cyst. The young worm just out of a cyst is generally elongated oval in shape. Under a slight pressure one may more clearly observe all the internal organs, the minute spines with which the body surface is provided and the excretory vesicle contracted in discharging its contents.

Animal Experiments with Encysted Larvae.—In the feeding experments I have used young cats and dogs. These animals were all brought from uninfested districts and were carefully examined that none of them was infected with lung distomes. Some of them have already died or been killed and used for study of the development of the young worms in these hosts, but the others are yet at the present under experimentation. I will here describe the results of some of my experiments.

(*A*) Young cat. The animal was fed with 20 cysts on July 26, 80 on the 28th, and 130 on August 2. These cysts were all taken from the gills of *E. japonicus* collected from Tokushima prefecture. The cat died August 10, having passed 16, 14 and 9 days after the first, second and third feedings, respectively. Before her death she was extremely anemic and atrophied. In dissection the next day, numerous cestode larvae were found in the body wall as well as in the body cavities, abdominal and pleural. Some portions of the body wall occupied by the worms had suppurated. It was easy to believe that the anemic and atrophic symptoms and consequently the death of the cat were caused by the presence of these larval cestodes.

In the abdominal cavity I found 18 young worms floating in serous fluid and adhering to the omentum, mesentery, and inner surface of the abdominal body wall, and in the pleural cavity 16 worms in serous fluid and on the pleural membrane. These young distomes in the body cavity were all nearly equal in size, measuring from 1 to 2 mm. in length in compressed specimens. The lungs were not yet occupied by the worms.

(*B*) Young cat. Fed with 80 cysts August 7 and killed on 17th of the same month, 11 days after feeding. All the cysts were collected from the same locality given in the preceding example. I found 5 young worms in the abdominal cavity and 6 in the pleural cavity. These worms measure about 1 mm. in length and 0.5 mm. in breadth. (Figure 6.)

(*C*) Young dog. Fed with 33 cysts August 14, 46 on 17th, 90 on 28th, 50 on 30th, and 32 on September 1. The cysts of the first and the second feedings were obtained from *E. japonicus* of Tokushima prefecture and all the remaining cysts were taken from *S. dehaani* of Ebie, a suburb of Osaka. The dog died September 29, having passed 46, 43, 32, 30, and 29 days after each corresponding feeding. Some inflammations were observed here and there in the inner surface of the intestinal wall. This seemed probably to have been caused by the action of the young worms of the lung distomes. I found also a great number of *Dipylidium caninum* and a few *Ankylostomum caninum* in the small intestine. Omentum and the mesentery were slightly congested here and there. There were numbers of perforations on the inner surface of the abdominal body wall. Around the perforations more or less hemorrhage was observed between the muscular layers of the abdominal wall. These perforations were evidently produced by the young worms which were found everywhere in the serous fluid or on the surface of various organs in the abdominal cavity where I had obtained 30 young worms. A number of perforations was observable on the diaphragm through which the young worms seem to have passed from the abdominal to the pleural cavity.

In the pleural cavity 43 young worms were obtained in the serous fluid and on the surface of the various organs: lungs, heart, and pleural membrane. The size and the shape of the worms in the body cavities were extremely variable according to the state of contraction. In fixed specimens, the length varies from 1.5 to 5 mm. and the breadth from 0.5 to 2 mm. I found a good specimen which is most favorable to demonstrate that the worm in the pleural cavity enters the lungs from its surface by perforating. Numerous worms in various stages of development were observed in the lungs. The worms of large size

in the lungs were plainly observable from the outside or easily felt by touching on the surface of lungs.

(*D*) Young cat. Fed with 4 cysts June 15, 1 on 16, and 3 on 17, and was killed on August 17. It was 62 to 64 days after the feedings. All the cysts were taken from the liver of *S. dehaani*. In the dissection of this animal I found 2 young distomes, one in the pleural cavity, the other in the right lung. The dimensions of this worm were about 4 mm. long and 2 mm. broad. The worm in the lung was not yet matured.

From my observations in the above experiments, I have learned the general course which the young worms travel from the intestine to the lungs of the host. Briefly stated, it is as follows:

The encysted larvae swallowed by a host come out of their cysts in the stomach or intestine through the action of gastric or intestinal juice. The larvae coming out of the cysts are actively mobile. They pierce the wall of the intestine. They stay for some time in the abdominal cavity and wander about here and there; thence they pierce through the diaphragm to enter the pleural cavity. Here again they stay for some time and finally penetrate into the lungs from their surface.

In addition to this general course, the young distomes in the abdominal cavity may also penetrate the abdominal wall and move around in the muscular layers of the connective tissues, as stated above in Case *C*. Some worms in the pleural cavity may proceed cephalad, taking their course through the loose connective tissues along the esophagus or the blood vessels. Thus the young worm of the lung distome has evidently a wandering power by which it can pass through the muscular and connective tissues. It is obvious that the discovery of the wandering character of the young worm throws light on the accounts of cerebral and spinal paragonimiasis which are attributed to the lung distomes.

October, 1915.

EXPLANATION OF PLATE

Fig. 1.—Cyst attached to lobule of liver of *S. dehaani.* x60.

Fig. 2.—Longitudinal section of the right third leg of *E. japonicus,* showing distribution of cysts. Natural size; b, basipodite; c, carpopodite; d, dactylopodite; g, gill; h, hypodermis; i, ischiopodite; k, muscle; l, encysted larvae; p, propodite.

Fig. 3.—Cyst from the gill of *E. japonicus.* x60; i, intestinal coeca; e, excretory vesicle; o, oral sucker; v, ventral sucker.

Fig. 4.—Larva escaping from cyst. x60.

Fig. 5.—Larva coming out of cyst; slightly compressed specimen. x60.

Fig. 6.—Young worm in abdominal cavity of young cat. x60; c, excretory canal; note also intestinal coeca.

PLATE

Fig. 1

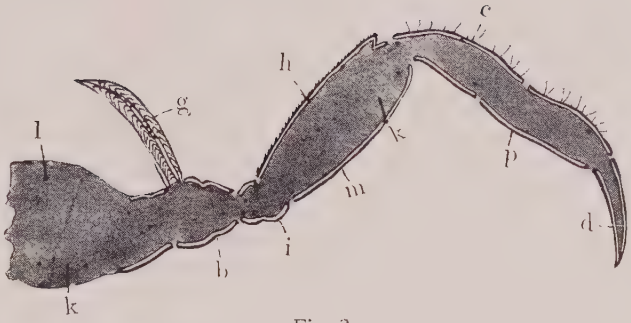


Fig. 2

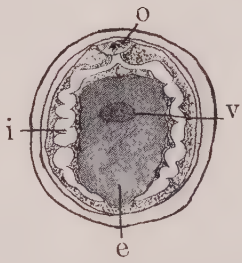


Fig. 3

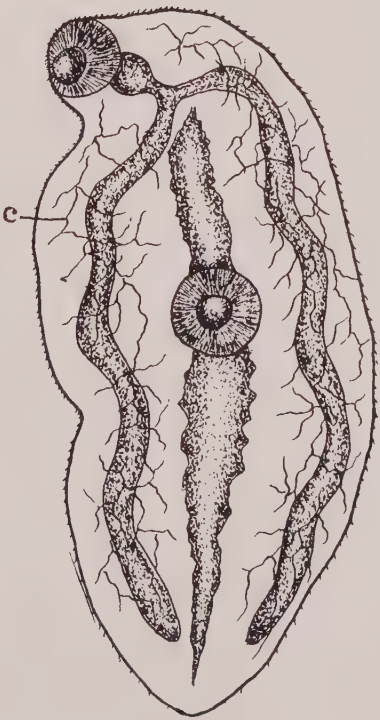


Fig. 6

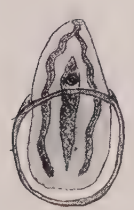


Fig. 4

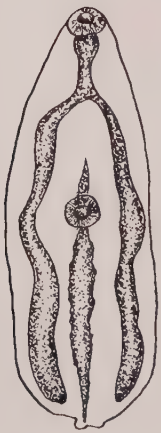


Fig. 5

GONGYLONEMA IN THE ROLE OF A HUMAN PARASITE *

HENRY B. WARD

Through the kindness of Dean Charles E. Brookover of the University of Arkansas Medical Department, Little Rock, I received recently a specimen of a nematode which has not heretofore been recorded as a human parasite. The worm was removed from the lip of a girl. The conditions surrounding the case are reported as follows by the attending physician, Dr. Robert Lee Covington of Jefferson, Ark., to whom I am indebted not only for the case history cited here, but also for replies to several inquiries on the matter necessary to perfect the record for publication. Dr. Covington's report is as follows:

Miss —, 16 years old. I was called to see her September 3. Found her suffering with considerable digestive disturbance, vomiting continuously for two or three hours; temperature 101.5 F. She felt chilly. I administered calomel followed with castor oil. Later I gave her full doses of turpentine and castor oil. The fever would come and go and for this I gave quinin. She improved some; later the fever abated entirely, but some digestive disturbance still persisted. She was very anemic and irritable. September 12 I dismissed her.

I was again called October 1. She wanted me to see what that was running around under the skin of her lip, as she expressed it. I thought it was pure imagination. She said she could see it by looking in the mirror; she said it looked like a worm, and at times she could feel it leave her lips and go back as far as the fauces. I examined the lower lip where she said it had stopped. I discovered the outline of what looked like a worm about three quarters of an inch in length and about the size of a No. 60 sewing thread; it was just beneath the mucous membrane. I inserted a needle under it and pulled out a little of one end, but before I could grasp it, it got away, moving back near the corner of the mouth. There I ran the needle under it midway between the ends and pulled upward, bringing a small loop through the mucous membrane. It held on so tight that the ends on each side of the needle cut their way out.

Up to this time she was extremely anemic and very cross and irritable, but after the removal of the worm she rapidly improved, her disposition changed, and now she is not like the same girl. She seems to be sound and well at this date.

DR. ROBERT LEE COVINGTON,
Jefferson, Ark.

Jan. 26, 1916.

In response to specific questions Dr. Covington stated that the worm moved up and down in the tissues three or four times, extending its migrations from the lips at least as far back as the fauces. It was actually seen by the patient three times and she reported it positively

* Contributions from the Zoological Laboratory of the University of Illinois, No. 59.

to her father the day before its removal. It could be discerned clearly enough to tell that it was a worm; in color it was a little lighter than the mucous membrane. During its movements the worm was definitely sensible to the patient only when it approached the skin and it was not seen or felt in this organ anywhere except on the inside of the lips. It was seen only inside the mouth through the thin mucous membrane of that cavity and so far as known did not approach the external skin save at the inner border of the lower lip.

From this record one may safely conclude that it migrated to and fro through the loose connective tissue beneath the oral mucosa and endeavored to move up into the firmer derma only when it approached the lips. From the fact that it evaded the surgeon for a time, one can see that the movement was free and active.

Subsequently Dr. Covington wrote regarding the patient: "She has lived here all her life, has not traveled in any other country. . . . Sanitary conditions are not just what they ought to be. They get drinking water from a well that is very shallow and fills up to the top when it rains heavily."

On preliminary examination it appeared that the specimen had suffered somewhat in the handling incidental to its forcible removal, and was not in such histological condition that much could be said definitely regarding its internal structure.

Under a dissecting lens the specimen (Fig. 1) is seen to be a nematode worm, light brown in color, semitranslucent, and loosely coiled, though both ends are nearly straight. The worm measures 42.1 mm. in total length and is of nearly equal diameter throughout, tapering only a little near the two ends which terminate rather abruptly.

The anterior end appears to taper more toward the bluntly round tip and for a space of 1.4 mm. from the end the surface is ornamented by various cuticular outgrowths like scales or tubercles. These are arranged in somewhat definite fashion (Fig. 2). A cuticular ridge extends along the lateral line of the body starting at a point about 0.25 mm. from the extreme anterior tip and running back about 1.5 mm. In the anterior region this ridge is slightly irregular but nearly equal in height at all points; further back it is divided by deep indentations into long ovals. At the place where it starts the diameter of the body is about 0.1 mm. and at its posterior end the body has increased in diameter to 0.19 mm.

In the submedian lines are rows of scales, plates, or tubercles that start just behind the front end of the ridge just described and extend backwards only about 1.1 mm. in definite and regular order. These tubercles stand in a linear series so close together that they are practically continuous even though separated from each other by a distinct boundary line. They vary in form and size but on the average

are nearly square in profile and measure 0.022 mm. in height and 0.025 to 0.3 or rarely 0.045 mm. in length. In front of this close-set series and of the cuticular ridge one finds a number of isolated cuticular bosses which in part line up with the ridge or the series and in part do not. Between the ridge and the series are a few isolated scales. These are irregular, detached, and on the average larger than the tubercles in the regular series.

The anterior tip of the body possesses a small infundibuliform crown surrounding the mouth which may represent a group of lips with some papillae. From the orifice a capilliform esophagus extends posteriad and disappears from view behind the anterior tip of the cuticular ridge. In the mid-ventral line about 0.6 mm. from the anterior tip is a peculiar papilla that probably surrounds the excretory pore. The location of the end of the esophagus is difficult to determine precisely; it appears to be about 7.5 mm. from the anterior end. Here the diameter of the body is 0.23 mm.; a measure which is maintained with only slight variations from 0.22 to 0.24 mm. approximately, throughout the entire length until the caudal region is attained.

The vulva is a ventral, slightly prominent pore with raised lips, located 2.15 mm. from the posterior tip of the body. Even behind it the body retains its uniform caliber of approximately 0.23 mm. until close before the anus or about 0.25 mm. from the exterior tip. This region is a little damaged by handling, but shows distinctly a slight concavity on the dorsal surface making the bluntly rounded posterior tip of the body turn a bit upwards. At the anal orifice the body measures 0.09 mm. in diameter, which is evidently somewhat less than normal owing to the injury already noted. The taper begins only a short distance anteriad to the anus, and if the specimen had been uninjured, would have been regular apparently from that point to the rounded tip. There is certainly no abrupt change in diameter either before or behind the anus.

There can be no doubt that this specimen belongs to the genus Gongylonema in the family of the Filariidae. Gongylonema is a nematode peculiar in habit in that it forms a sinuous gallery in the mucous epithelium of the esophagus. The worm lies in this tunnel with the anterior region alone projecting from it. With a single exception all species are found in mammals. The body is very long and thread-like, showing a slight taper toward both extremities. The characteristic feature of this genus is the presence on the anterior region of a considerable number of scales or tubercles which are elevated thickenings of the external cuticula only. These differ in size, number, and arrangement in different species. Cuticular folds stand out from the surface along the median or lateral lines in the

anterior region, and form conspicuous features in the external aspect of the worm. These also vary in number, form, and extent in various species. The vulva is located near the posterior end, and its precise position as well as the form and size of the tip of the tail are valuable in determining the species of female specimens.

Two species of Gongylonema are common to domestic animals in the United States, and fall under suspicion as possible occasional parasites of man. These are *G. scutatum* and *G. pulchrum*. Of *G. ingluvicola* Ransom from chickens it need only be said that the structure of the adult is too dissimilar to allow of the surmise that this specimen is an erratic individual of that species. But the other two are much alike in structure and are abundant in some parts of this country, if not in most regions; they are also both very similar to the specimen under consideration.

G. scutatum was recently described with some care by Ransom (1911) who declares that it is very common in this country and can be found in a large percentage of cattle and sheep slaughtered at abattoirs.

G. pulchrum is known as a parasite of the hog in Europe, and has been found also in North Africa by Seurat (1912). It does not seem to have been reported in print from the United States previous to this year when it was briefly mentioned by Ransom and Hall (1916) in connection with the discussion of experiments on the life history of *G. scutatum*. They have found it to be frequent in the vicinity of Washington, D. C., and it doubtless occurs abundantly in the pig in other regions as well. Dr. B. H. Ransom was good enough to send me specimens for comparison. These came from the collections of the Bureau of Animal Industry and were taken from a hog at Bethesda, Md., in January, 1914.

These two species are very similar, and in the present case it is impossible to assert positively which one is the specimen under consideration. It agrees in length with *G. pulchrum* and as nearly as can be ascertained also in the character of the female genital organs of which a comparative study has been published by Seurat (1912). The caudal tip is also slightly concave on the dorsum as has been described in that species. However, this specimen is a trifle over ordinary length for *G. pulchrum*, although it has not yet reached full sexual maturity. But the genital pore is salient, although not notably so, a feature which is said to be characteristic of *G. pulchrum* though wanting in *G. scutatum*. On the whole, I am inclined to determine the specimen from man as *G. pulchrum*. The common ascarid of man, the stomach worm, *A. lumbricoides*, is also a parasite of the pig in which it occurs abundantly in all parts of the country.

The specimen under consideration manifested a habit that so far as known is not characteristic of the genus to which it must be assigned. It was engaged in active migrations through the subdermal connective tissue, and the patient was conscious of the fact. It had approached near enough to the surface to be seen and correctly diagnosed in form, and had wandered away into deeper tissues. The worm may have been thus active over a period of a month or less. It moved through the connective tissue rapidly enough to render its capture and removal a matter of skill and dexterity. Such performances are not reported in other accounts of the genus, which as already noted is found in the mucosa of the esophagus in its normal host, and has not been collected from other organs or regions. The presence of the chicken species in the wall of the crop is not a real departure from this general habit for it occurs there in the mucous lining according to Ransom's report. It is, of course, possible that these forms regularly inhabit the subdermal connective tissue during a period of their life cycle and appear in the esophageal mucosa at the time of sexual maturity; or such an occurrence may be exceptional but actual in the normal host also. In that event it would readily escape notice under usual conditions. There is no basis for deciding whether such wanderings are usual but unnoted heretofore in the normal host, so rare in it as to have evaded observation thus far, or peculiar to the human host or to this particular case.

The habit recalls very strikingly the wandering through subdermal tissues of the African eyeworm, *Filaria loa,* which has received its name from its frequent appearance in the subcutaneous connective tissues near the eyeball. It is also well known to occur in the same tissues elsewhere in the body. Among the cases on record are a few which report its removal from the lip or near the same, but it occurs habitually near the external skin and is not reported from the vicinity of the mucosa. Yet it is not at all impossible that in some instance where no careful examination was made a specimen of Gongylonema has been interpreted as the loa. The length of the specimen reported here and its appearance agree in general with the loa, and while it is not quite so heavy nor so opaque, the two might readily be confused if no careful microscopical examination were made; all the more so since the loa is the only nematode which has been known to move about in subdermal tissues and that striking habit would have been taken to indicate the type of parasite at hand.

There are other records of parasitic nematodes from man in this country that should be brought briefly under consideration in connection with the case in hand. In 1850 Dr. Joseph Leidy of Philadelphia

described a human parasite as *Filaria hominis oris* from a specimen in the collection of the Philadelphia Academy labeled "obtained from the mouth of a child."

This account of Leidy has always been difficult to interpret. His conjecture that it was a young Dracunculus or Medina worm has been generally rejected and other suggestions are not entirely satisfactory. The location suggests that the specimen may have been a Gongylonema, not the species here reported for that is much too short, but *G. scutatum* of cattle and sheep which is of the right dimensions. Leidy was a very accurate observer and it is improbable that he would have overlooked the cuticular tubercles on the anterior end if such had been present. The condition of the specimen might have been such as to prevent the diagnosis of these structures, but on the whole the case can hardly be assigned to Gongylonema even tentatively.

The source of the infection in the case at hand can not be positively ascertained and yet recent studies suggest a very probable explanation. Thanks to the careful work of Ransom and Hall which has extended over several years it is now known that the larvae of *G. scutatum* occur in various species of dung beetles and that they have been raised experimentally not only in these but also in croton bugs. Furthermore, eggs of a Gongylonema, most probably *G. pulchrum* from the esophagus of a hog, were fed to croton bugs and at the close of a month embryos were found encysted in the final stage and ready for transmission.

In the present case it is easy to see how an infected insect, very likely a croton bug, might have been ingested whole, or some fragments of it included by accident in meal, flour, milk, or other materials used in cooking. Such sanitary mishaps are very common with poorly prepared food, and thus the infection of the human host would have been achieved. The sanitary conditions noted in the clinical history of the case favor such an occurrence.

The duration of the infection can be estimated as at least a month if the clinical symptoms stand in any connection with the parasite. No data have been found to show the rate of development of these worms in the final host but if one can infer safely from other nematodes it is likely that this specimen was in the human host more than a month and that the symptoms did not manifest themselves until it had attained a certain measure of growth. These symptoms were so definite and terminated so promptly with the removal of the parasite that etiologic significance can hardly be denied to the worm.

SUMMARY

A specimen of Gongylonema, probably *G. pulchrum*, has been recovered from man. This species is normally a parasite of the pig.

PLATE

Fig. 1

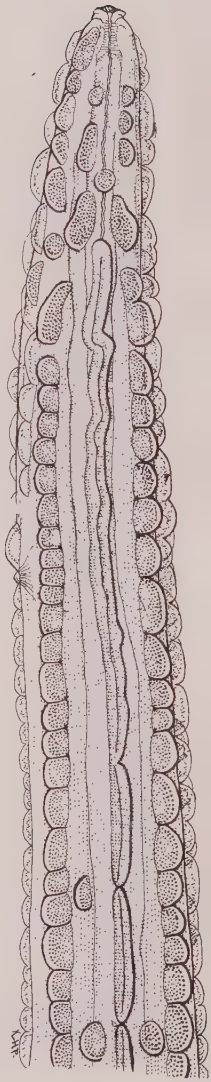


Fig. 2

EXPLANATION OF FIGURES

Fig. 1.—Gongylonema (pulchrum?) from human host. Camera drawing. X 15.

Fig. 2.—Anterior end of same specimen. Camera drawing. X 140.

Infection of the human host was brought about probably by the ingestion of larvae in the infective stage which had developed in some insect. Very likely the croton bug, known by experiment to be able to serve as intermediate host for this species, was the source of the infection which might readily occur by accident.

The presence of the parasite was accompanied by clinical symptoms indicating marked digestive and nervous disturbances, associated with anemia. These symptoms disappeared with the removal of the worm.

The parasite displayed a tendency to wander through the submucosal connective tissue from the lips to the throat.

Papers Cited

Leidy, Jos. 1850. Description of Three Filariae. Proc. Acad. Nat. Sci., Phila., 5: 117-8.

Neumann, L. G. 1894. Sur le genre Gongylonema Molin. Mém. Soc. Zool. France, 7: 463-473; 4 figures.

Ransom, B. H. 1904. A New Nematode (*Gongylonema ingluvicola*) Parasitic in the Crop of Chickens. Bur. An. Ind., Circ. 64. 1911. The Nematodes Parasitic in the Alimentary Tract of Cattle, Sheep, and Other Ruminants. Bur. An. Ind., Bull. 127.

Ransom, B. H., and Hall, M. C. 1916. The Life History of *Gongylonema scutatum*. J. Parasitol., 2: 80-86.

Seurat, L. G. 1912. Sur l'appareil génital femelle des Gongylonemes. C. R. Soc. Biol., 73: 276-9; 5 figures.

ARE SARCOSPORIDIA ABERRANT FORMS OF CNIDOSPORIDIA OF INVERTEBRATES?

B. Galli-Valerio
University of Lausanne

In the year 1910 v. Ràtz stated that Sarcosporidia are very near to the Nosematidae. In an interesting paper Darling (1915) writes: "On account of the facility with which herbivora may obtain and ingest invertebrates infected with Neosporidia, but more particularly flowers, leaves, etc., or water contaminated with droppings of bees, moth larvae, fly droppings, etc., or other material containing Neosporidia spores, is it not possible that Sarcosporidia may be side-tracked varieties of some of the Neosporidia of invertebrates which have invaded the musculature of a hospitable though by no means definitive host and, being unable to continue further their life cycle, have escaped from a compromising and aberrant position?"

This opinion of Darling was supported by the experiments of Scott (1915) who concludes his paper with the following words: "All of the evidence favors the view that the sheep is not the definite host of *S. tenella* and, therefore, is in accord with Darling's suggestion that the muscle parasites of vertebrates are aberrant forms."

In such an order of ideas it is perhaps interesting to note observations which seem to me to support the hypothesis that Sarcosporidia are identical with Cnidosporidia.

In 1896 Piana, in a paper on the life cycle of *Balbiania gigantea-S. tenella,* states that in the cultures of this parasite on sterilized moist filter paper, moist earth, gelatine prepared with *Focus crispus* at a temperature of 18 to 25 C. in twenty-five to sixty days the spores give bodies which develop more and more and present a nucleus and ameboid movements. The movements cease after some days and the amoeba assumes the form of a cyst. Piana tried to infect a sheep per os with this material, but with negative results. I may add the macroscopic examination made with a view to finding cysts of Balbiania, was confined to the esophagus.

After seventeen years I repeated (1913) the experiments of Piana with *S. muris,* making cultures of this on sterilized filter paper moistened with physiological salt solution at a temperature of 20 C. After eight days I found in this culture amoeboid bodies showing slow movement at a temperature of 20 and 37 C. This amoeba had a fine granulated protoplasm, a nucleus, and clear vacuoles. Colored with Leishman or Giemsa the protoplasm assumed an azure color, and the

nucleus a red color. After thirty-two days the cultures presented only encysted forms. With this culture I inoculated a white rat and a black mouse in the muscles of the thigh but without result. The inoculation of a white rat with *S. muris* was negative, as was also the infection per os of a guinea-pig with the same *Sarcocystis*. Neither Piana nor I affirm that the amoebae were positively derived from the spores of Sarcocystis, but we stated that it was very probable; and the observation of Erdmann (1914) that in the intestinal cells of a mouse infected per os with Sarcosporidia appear little amoeboid bodies, seems to support our experiments and the fact that Sarcosporidia are identical with Cnidosporidia. This idea was also expressed by Auerbach (1910) who says: "Mit der Tatsache des vorhandenseins einer Polkapsel bei Sarcosporidiensporen fällt ein wesentlicher Unterschied gegenuber den Cnidosporidian fort und es liegt kein zwingender Grund vor, sie noch von diesen zu trennen."

If it is possible to demonstrate that spores of Sarcosporidia produce amoebae, the identity of the two orders is more probable. The drawings of the amoebae of *Myxidium inflatum, leptotheca macrospora* and *Myxidium bergense* in Auerbach (1910: 10, 79) are very likely the drawings of amoebae of *S. muris* shown in my paper.

Given the spores of the Sarcosporidial amoebae, the infection with Sarcosporidia must be analogous with the infection with Cnidosporidia. The experiments of Thélohan and particularly those of Auerbach on the development of the Cnidosporidia in the intestine of fishes prove that the spores of this parasite produces amoeboid bodies in the duodenum. It is probable that the spores of Sarcosporidia must also produce amoebae in the intestines and perhaps in Piana's experiments the amoebae were destroyed in the stomach. In fact Auerbach failed to observe a transformation of spores of Cnidosporidia in the stomach of fishes. I think it would prove an interesting experiment to make cultures from the great cysts of *S. tenella,* and to introduce the amoebae directly into the intestines of sheep. With such a method of infection it is perhaps possible to secure much more positive results than to work with spores of *Sarcosporidia* which as Auerbach states are in some cases probably not ripe.

SUMMARY

1. The observations of Piana and Galli-Valerio to the effect that spores of Sarcosporidia produce amoebic bodies in cultures, more closely relate the Sarcosporidia to the Cnidosporidia.

2. If true that Sarcosporidia are only aberrant forms of Neosporidia of invertebrates, then the hypothesis of Darling becomes more probable.

PAPERS CITED

Auerbach, M. 1910. Die Cnidosporidien. Leipzig, 261 p., 4 pl.

Darling, S. T. 1915. Sarcosporidia Encountered in Panama. J. Parasit., 1:113-120.

Erdmann, Rh. 1914. The Schizogony of Life Cycle of *Sarcocystis muris*. Proc. Soc. Exper. Biol. Med., 11:152-153.

Galli-Valerio, B. 1913. Notes de parasitologie et de technique parasitologique et observations sur quelques tumeurs des animaux. Cent. Bakt. i, Orig., 69:496-504.

Piana, G. P. 1896. Fasi evolutive dei sarcosporidi. Mod. zooiatro, Torino, 6:145-147.

Ratz, von S. 1910. Ueber die Struktur dei Sarkosporidienschlaüche. Arch. weiss. prakt. Tierheilk. Suppl. 36:573-589.

Scott, J. W. 1915. Some Notes and Experiments on *Sarcocystis tenella*, Railliet. Jour of Parasit., 2:20-24.

THREE NEW GREGARINES FROM MARINE CRUSTACEA *

MINNIE E. WATSON
Oyster Bay, Long Island, N. Y.

The protozoan parasites described here were studied during the summers of 1913 and 1914 at the Biological Laboratory of the Brooklyn Institute, Cold Spring Harbor, L. I., and I wish to thank Dr. C. B. Davenport, the director, for kindly affording me the privileges of the laboratory.

All the hosts were found on the Sand Spit, a narrow peninsula half a mile long separating the outer and inner harbors. The area is thus geographically very restricted, and although the hosts are similar and the possibility of all of them being infected with the same parasite considered, yet there is abundant evidence to warrant regarding the three forms described below as separate species.

Frenzelina delphinia nov. spec.

Figures 1 to 8

The host of this gregarine is the large white sand flea, *Talorchestia longicornis,* which is found in fine sand between tide marks. Fleas were taken from the eastern end of the Sand Spit, and also from locations along the road to Lloyd's Neck, from Huntington Beach, and from Northport Harbor; and hosts from all these localities were found to be infected.

The parasites were present in 30 per cent. of the 260 intestines examined, the number in an infection varying from one to ten in 75 per cent. of the hosts and from ten to 500 in the other 25 per cent.

The sporonts (Figs. 1 and 2[1]), which live free in the lumen of the upper part of the intestines, are small, the average of fifty large individuals being 110μ in length and 60μ in width. The largest individual seen measured 115μ in length and 64μ in width. The ratio of length of protomerite to total length of sporont is about 1:4; the ratio of width of protomerite to width of deutomerite about 1:1.5. A table of a few measurements is given at the end of this section.

The sporonts are biassociative when mature and the two members of an association do not differ materially in size; either the primite or the satellite may be a little longer or broader than the other. The sporonts are stout bodied, being less than twice as long as wide. The

---

* Contributions from the Zoological Laboratory of the University of Illinois, under the direction of Henry B. Ward, No. 60. Also from the Biological Laboratory, Cold Spring Harbor.

[1] For explanation of special terms used see description of Figure 1.

protomerite is cylindrical and broadly rounded in front and is about three fourths as high as wide. There is often a slight constriction at the septum which separates the protomerite and deutomerite. The deutomerite is doliform, two thirds as wide as long, widest through the middle portion, and terminates in a broadly rounded extremity. There is a small conspicuous papilla at the anterior end of the protomerite of the young sporonts which persists, although reduced in size, in the adults. In the satellite of an association it becomes a structure for the attachment of the two sporonts by projecting upward and forming a small indentation in the posterior end of the primite (Fig. 4). Hydrochloric acid, either dilute or concentrated, fails to dislodge the two sporonts, but sodium hydroxid or ammonium hydroxid, in solution, readily disassociates them.

The endocyte of the mature sporonts is light brown in color and in full-grown animals fairly dense, and the nucleus not visible. Young sporonts are less dense and the color paler. The satellite of an association is generally less dense than the primite, and for this reason its nucleus is often visible in vivo when that of the dense primite is not. The protomerite of a sporont is slightly less dense than the deutomerite and contains fewer protoplasmic granules; the granules are slightly larger than those in the deutomerite and the endocyte paler in color. When the host has just been taken and has probably fed the night before, full grown sporonts are dense; when, however, the fleas have been kept in damp sand for a few days without food, the parasites are likewise deprived of nourishment and become pale in color and the number of protoplasmic granules present, hence the density, is greatly reduced. The addition of a drop of iodin solution renders these pale parasites visible but of course kills them.

The nucleus of the sporonts is generally visible in vivo only as a lighter indefinite area although in young and starved sporonts it is often visible. It is large and spherical and contains one or two large homogeneous karyosomes. The epicyte is thin and fragile and is marked with longitudinal striations only visible under an oil immersion lens.

Cross sections made of the intestine of the host reveal the fact that development is intercellular as in the family of the Stenophoridae. This is the first genus of the family Gregarinidae which has been found to develop in this manner, the other members possessing an epimerite which alone is attached to the host cell, the remainder of the trophozoite projecting into the lumen of the intestine. In the species here described, the whole trophozoite is embedded in the epithelium (Figs. 3 and 6). When stained with Delafield's hematoxylin, the cells of the epithelium become purplish-blue, while the parasites stain less deeply and the color is a clear homogeneous blue with a darker blue nucleus.

The animals are capable of movements both of bending and of gliding progression. The sporonts are able to move through a narrow place in the manner employed by an amoeba. When the host intestine is first opened, a mosaic of inert distorted individuals or associations lying near the epithelium is often revealed; when, however, water or normal salt solution is added, the smooth, regular contour is quickly restored. Normal salt solution stimulates movement and sporonts often remain alive and motile for an hour and a half. Sea water has the same effect. As motion tends to be retarded at the end of this time, weak tannic acid solution was added in a few instances and caused considerable acceleration of movement; plasmolysis, however, occurred inside of another half hour and the animals died.

That transparent threads of mucus are present at the posterior end of the body was frequently attested by the fact that the animals were able to carry with them in their movements large or small masses of débris at a distance behind the body often as great as the length of the animal itself. A mass twenty-five times the volume of the gregarine itself was in one instance observed being carried along.

Cyst formation was observed in material from the host intestine from its incipiency until rotation ceased. The adult sporonts free in the intestine which are ready for cyst formation become thickened and shortened, motion becomes sluggish, movement of progression ceases and that of bending becomes more active (Fig. 5). Concomitant with the revolving motion there occurs a deposition of gelatinous threads exuded from the body in fine concentric layers around the revolving mass. The sporonts become a spherical mass and the threads form a thick cyst wall. The rotating mass passes from the mid intestine to the rectum and ceases motion (Fig. 7). It begins here its development by the loss of the wall separating the two sporonts and the disintegration of the two sporont nuclei. The protoplasm of the cyst collects in masses and on the periphery of each protoplasmic mass are formed spherical protuberances, the gametids. The cyst is now expelled with the feces. Cysts when expelled are somewhat opaque, tan in color, and average 80μ in diameter, including the cyst wall.

It is difficult to effect cyst development to completion by artificial methods. Marine bacteria seem to be virulent and to cause putrefaction or otherwise stop development in the early stages. Cysts were kept in the damp chamber in normal salt solution and a few yielded gametes upon being crushed when 24 hours old. The gametes were stained with safranin; they were large and nearly spherical, and no difference in size was observed in those from the same cyst. Some of the gametes, however, showed large deeply staining nuclei and others smaller nuclei which stained less deeply, probably because of their reduced chromatin

content. A difference in the staining reaction was also noted in the two sporonts in a cyst of about eighteen hours, the one sporont mass staining more deeply than the other.

A very few cysts developed to completion and dehisced by simple rupture in 35 hours, but no well formed spores were present.

Orchestia agilis, the smaller very common sand flea, was found in one instance to be infected with three nonassociative sporonts which agree in size and shape with the species described above. This flea was also heavily parasitized with an infusorian. *Orchestia grillus* from the roots of the eel grass (*Juncus palustris*) was not found to be infected with gregarines.

The genus Frenzelina (Léger and Duboscq, 1909) has not hitherto been reported from the United States and only seven species have been described. The species described above is placed in this genus because (1) the sporonts are biassociative, (2) the cysts dehisce by simple rupture, (3) development is intercellular, (4) the apex of the protomerite is slightly papillated, (5) the parasite inhabits the intestine of a crustacean.

I wish to designate the species, of which no previous record is found, *Frenzelina delphinia.*

The fact that development is intercellular was not determined by Léger and Duboscq and this important fact should be added to the features which characterize the genus Frenzelina.

A table of typical measurements, in microns, follows:

Total length association	215	215	210
Primite:			
Total length sporont	115	110	112
Length protomerite	20	24	27
Length deutomerite	95	86	93
Width protomerite	39	35	43
Width deutomerite	62	66	63
Ratio length protomerite: length deutomerite	1:4.7	1:4.6	1:3.5
Ratio width protomerite: width deutomerite	1:1.6	1:1.8	1:1.5
Satellite:			
Total length sporont	100	105	98
Length protomerite	20	20	20
Length deutomerite	80	85	78
Width protomerite	37	40	40
Width deutomorite	55	56	60
Ratio length protomerite: length deutomerite	1:1.5	1:1.4	1:1.5
Ratio width protomerite: width deutomerite	1:1.5	1:1.4	1:1.5
Cyst, outer diameter	77	90	86
Inner diameter	63	74	66
Thickness transparent layer around cyst	7	8	10

Frenzelina olivia nov. spec.

Figures 8 to 10

The host of this species is the small littoral spider crab, *Libinia dubia,* which is abundant along the shores of Long Island Sound and its inlets. The parasite is found in the upper part of the intestine. It generally occurs in moderate numbers (10 to 100) but rarely an infection of 1,000 or more is encountered.

The sporonts are biassociative and average 80μ in length and 35μ in width. They are ellipsoidal in shape, rounded in front and rather blunt posteriorly. The protomerite is hemispherical, very slightly constricted at the septum. It is about one fifth the total length of the sporont and slightly papillate in the adults (Fig. 8); the younger solitary sporonts possess a conspicuous papilla (Fig. 10). The deutomerite is but little wider than the protomerite (1:1.2); in solitary individuals it is more broadly rounded at the posterior end than in those which are attached. The endocyte of the mature sporonts is dark brown and very dense in the deutomerite; the protomerite is less dense and tan in color. At the anterior end of the protomerite is an orange colored disc. The nucleus is visible only in immature specimens. It is spherical and generally contains one large karyosome.

Movement of progression is rapid and continues only for intervals of about two seconds.

Cysts are spherical, dark brown in color, and from 45 to 60μ in diameter including the enveloping wall. They occur in the posterior third of the intestine. No sections were made of the host intestine.

This species is placed in the genus Frenzelina because (1) it is biassociative, (2) there is a papillated conspicuously differentiated apical area in the protomerite, (3) it is very similar to *Frenzelina delphinia* in form and location and both occur in hosts from the same habitat; (4) it is parasitic in the intestine of a marine crustacean.

The larger spider crab, *Libinia emarginata,* which is found in deeper water and seldom comes near the shore, has been examined repeatedly for gregarines, but none have been found to date. Other crabs procured from oyster boats, and which were dredged in the Sound and Harbor, have not yielded gregarines. These include *Neopanope texana sayi, Carcinides maenas, Pagurus bernhardus* and *Pagurus longicarpus;* and *Chloridella empusa* from the mud flats of the Inner Harbor. From the south side of the island, the following crabs have been examined and none found to be infected with gregarines: *Emerita talpoida, Callinectes sapidus, Ovalipes ocellatus, Ocypoda albicans,* and an undetermined species of Orchestia.

It seems possible that only littoral marine crustacea are infested with gregarines and that spores are eaten along with shore vegetation,

grasses and tide water algae, and are swept away by the tides or are noninfective when they reach the water.

A table of measurements, in microns, follows:

Total length association	218	195	150	127
Primite:				
Length sporont	100	85	80	65
Length protomerite	20	20	14	14
Length deutomerite	80	65	66	51
Width protomerite	35	38	30	30
Width deutomerite	43	48	45	36
Ratio length protomerite: total length sporont	1:5	1:4.2	1:5.7	1:4.6
Ratio width protomerite: width deutomerite	1:1.2	1:1.3	1:1.5	1:1.2
Satellite:				
Length sporont	118	110	70	62
Length protomerite	25	14	10	10
Length deutomerite	83	96	60	52
Width protomerite	36	39	22	22
Width deutomerite	36	50	28	30
Ratio length protomerite: total length sporont	1:5	1:8	1:7	1:6.2
Ratio width protomerite: width deutomerite	1:1	1:1.3	1:1.3	1:1.4

Frenzelina nigrofusca nov. spec.

Figures 11 to 14

Two species of fiddler crabs, *Uca pugnax* and *U. pugilator, which* live together at the roots of the eel grass, were found to be infected with a species of gregarine. About 30 per cent. of the hundred or more crabs examined were parasitized and the infection was very moderate; in only rare instances was the number of parasites present greater than fifteen.

The sporonts were solitary, none being associative as is characteristic of this genus. The body is broadly ovoidal, less than twice as long as wide (Fig. 11) and is often nearly rectangular in shape with rounded corners (Fig. 12). Sporonts average 100μ in length and 65μ in width. The protomerite is hemispherical and very slightly constricted at the septum; it is about one third the length of the whole sporont. There is a minute papilla at the anterior end; this papilla is large and conspicuous in the trophozoite (Fig. 13). The deutomerite is of approximately the same width as the protomerite and twice as long. It is very broadly rounded or often flattened posteriorly.

The endocyte is very dense and appears dark brown or black in transmitted light. It is but little less dense in the protomerite than in the deutomerite and in starved animals becomes tan in color. The nucleus is not visible in the live sporonts. The sarcocyte is relatively thick, especially over the anterior end of the protomerite. The nucleus

is small and spherical and contains one or two minute karyosomes. Uniform gliding movement was observed at a relatively slow rate. The cysts are very dense and are spherical. Spores were not seen.

This species is placed in the genus Frenzelina for two reasons: (1) the protomerite possesses at its apex a small papillated and conspicuously colored disk, this papilla being well developed in the trophozoite, (2) the gregarine infects the intestine of a marine crustacean. While no associative sporonts were seen, the species is very probably associative from its affinities.

A table of measurements of a few specimens is appended here, all dimensions being given in microns:

Total length sporont.....	72	82	100	120	125
Length protomerite	20	22	22	31	31
Length deutomerite	52	60	78	89	94
Width protomerite	39	40	70	50	75
Width deutomerite	37	40	75	75	65
Ratio length protomerite: total length	1:3.6	1:3.9	1:4.5	1:4	1:4
Ratio width protomerite: width deutomerite	1:1	1:1	1:1	1:1.5	1:2.1
Diameter nucleus	1	1.1	1.5		

SUMMARY

1. Three new Gregarine parasites of the genus *Frenzelina* are described from marine Crustacea.

2. Parasites belonging to this genus have not hitherto been reported from the United States.

3. A new definitive character for this genus has been determined upon sectioning the host intestine, namely, the fact that the parasites are intercellular.

Reference Cited

Léger, L., and Duboscq, O. 1909. Etudes sur la sexualité chez les Grégarines. Arch. Prot., 17: 19-134.

EXPLANATION OF PLATE

Frenzelina delphinia nov. spec.

1. An association of two sporonts from lumen of intestine of *Talorchestia longicornis; a,* protomerite of sporont, *b,* deutomerite, *c,* primite, *d,* satellite.
2. Another association with satellite much younger than primite.
3. Cross section of portion of intestine of *Talorchestia longicornis* showing intercellular development of parasite; *a,* oblique section of trophozoite embedded in epithelium; *b, c,* sections of sporonts lying free in lumen but near the walls and surrounded by mucus.
4. Interlocking device by which satellite of association is attached to primite.
5. Association revolving in an early stage of cyst formation.
6. Cross section of portion of host intestinal epithelium showing embedded trophozoite in longitudinal section.
7. Cyst soon after completion, showing transparent cyst wall and two sporonts still distinctly outlined.

Frenzelina olivia nov. spec.

8. Mature association from lumen of intestine of *Libinia dubia.*
9. Immature sporont from same location.
10. Young sporont free in intestinal lumen, showing papilla at anterior end of protomerite. Magnification greater than in Figures 8 and 9.

Frenzelina nigrofusca nov. spec.

11, 12. Adult sporonts from lumen of intestine of *Uca pugnax.*
13. Trophozoite from lumen of host, showing papilla.
14. Sporonts with posterior half of body contracted, indicating that considerable movement of the body is possible.

PLATE

THE PAJAROELLO TICK (*ORNITHODORUS CORIACEUS* KOCH)

WITH SPECIAL REFERENCE TO LIFE HISTORY AND BITING HABITS

WILLIAM B. HERMS
University of California

For several years previous to beginning his observations on this species, the writer has listened to many harrowing tales about the *Pajaroello*. No one seemed to know exactly what it was and no one seemed to have collected specimens so as to make accurate identification possible in so far as the writer knew at the time. Complaints came almost exclusively from the more mountainous portions of Santa Clara and San Benito Counties (California). Natives, principally Mexicans, in the vicinity of Mt. Hamilton fear this parasite more than they do the rattlesnake, and tell weird tales of this or that man having lost an arm or leg, and in one instance even death having ensued, as the result of a bite by the Pajaroello. There seems to be a superstition in that region that three bites will result in certain death. The stories all agree in the essential detail that the bite results in an irritating lesion which is slow to heal and often leaves an ugly deep scar. Several persons also informed the writer that the Pajaroello occurred in certain mountainous portions of Mexico. It was not, however, until August, 1913, that living specimens came to hand, taken in Santa Clara County in the vicinity of Mt. Hamilton. These were identified as *Ornithodorus coriaceus* Koch, described in 1844 from a single female specimen from Mexico. A translation by Nuttall of the original description is as follows:

"Shaped like the sole of a shoe, thick margined, roughly shagreened, yellowish earthy color, spotted rusty red, legs toothed dorsally. Length 9.3 mm. Body about twice as long as wide, width fairly uniform, indented on the sides, pointed above the mouthparts, rounded posteriorly, a thick turned-up border all around; the whole surface above and below thickly granulated like fish skin (shagreen), the granules flat above, consequently, the whole leathery, on the back unequal folds and grooves. Beneath in the front of the body a deep groove running to the stigmata and on the inner protrusion the rather large round quite clearly marked eyes. The coxae gradually thicken toward the distal extremity and are somewhat bent; the other articles somewhat compressed and clearly notched or round-toothed. The whole surface, above and below, dirty yellowish earthy color, rusty red spots irregularly distributed throughout. Capitulum and palps light yellow. Legs gray-brown. Female. Male: unknown. Habitat: Mexico."

From either specimens received or reliable information at hand it now seems evident that this species occurs in the more mountainous portions of the following counties in California, namely, San Benito, Santa Clara, Stanislaus, Monterey and Santa Barbara, probably also Los Angeles and San Diego, thus connecting up with Mexico, which is probably the original habitat. The tick is most commonly found among the dry leaves beneath live oak trees where cattle are accustomed to lie in the shade. Most cases of tick bite caused by this species have occurred while sitting or lying down in such situations.

This species of tick is a typical representative of the genus *Ornithodorus* of the family Argasidae and is superficially not greatly unlike the relapsing fever tick of Africa, namely, *Ornithodorus moubata* Murray.

Since August, 1913, the complete life history of this tick has been worked out and much information has been gained relative to its habits and venomous properties. In this work the writer has been greatly assisted by several of his advanced students, notably Mr. W. L. Chandler, who has undertaken an exhaustive study of this species.

LIFE HISTORY

Six adults and half-grown specimens, males and females, were secured during the month of August, 1913. Of these Tick No. 6, a fully grown female, engorged on blood from a Rhesus monkey, November, 1913, deposited a lot of eggs Feb. 13, 1914, and continued to lay eggs at intervals during the rest of that season. Various experiments were performed with the ova and the several larvae resulting from the first laying, mainly for the purpose of determining the best method of procedure. From the second laying of this tick we secured our first complete life history data as follows: March 9, Tick No. 6 deposited 323 ova, hatched March 31; giving an incubation period of about 21 days at an incubator temperature averaging 26.3 C. (variation $\pm$ 1 C.). The larvae were placed on the ear of a rabbit May 2 and among others one was recovered fully engorged May 11, and given the number 18. The first moult occurred May 21, giving about 51 days for the larval stage in this instance. The second moult without a second engorgement took place June 15. The nymph became fully engorged in about twenty minutes on July 2, the third moult occurring August 12. Becoming fully engorged again October 11, the fourth moult took place December 23. Engorging again Jan. 16, 1915, the fifth moult took place March 9 and the sexually differentiated tick (a female) appeared. March 27 it became fully engorged on a mouse and was placed with male No. 3 on April 16, copulation taking place April 17. The first laying consisting of 428 eggs took place June 10, 1915. Thus the egg to egg period in this

invidual covered exactly fifteen months. This time can be reduced very considerably by applying the ticks to a suitable host animal at shorter intervals, indeed we have one record of a male in which sexual differentiation was accomplished in 159 days, as against 343 days in Tick No. 18, a female. Under natural conditions it seems quite probable that there is one generation each year and that two years may be necessary in many instances.

Although the incubation period at a given sustained temperature suffers little variation, e.g. at 26 C. it is 21 days, the length of time required for the other stages varies considerably, depending on the presence of a host mainly.

The minimum length of the larval period was found to be 19 days. The number of moults varies from four to seven.

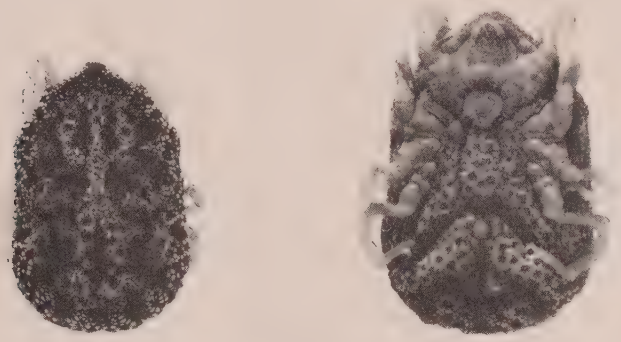


Fig. 1.—The Pajaroello tick, *Ornithodorus coriaceace* Koch. Dorsal, left; ventral, right.

The length of time a female may remain fertile without further copulation is at least two years as shown by the fact that Tick No. 6 received as a fully grown individual August, 1913, and not thereafter placed with a male, deposited eggs during the summer of 1914 and 1915. The total number of eggs deposited in one season by Tick No. 6 was 1,158, there being seven separate layings. The maximum number of eggs deposited in a single lot for the year 1914 by Tick No. 6 was 323. This same tick, however, deposited 802 eggs April 26, 1915, her tenth laying in captivity, and her daughter, Tick No. 18, deposited 428 in her first laying.

We have experienced no little difficulty in rearing this species of tick. However, the ear of a rabbit is best suited for feeding the larval ticks; later stages are best fed by placing the ticks either on a rabbit or on a mouse, holding these with the hands until the ticks have become fully engorged and drop off, this process requiring from 15 to 30 minutes.

BITING HABITS AND VENOMOUS NATURE

Mr. W. L. Chandler, a graduate student in the University of California, formerly with the United States Public Health Service, has given the writer an accurate account of two bites which he suffered while stationed in the San Antone Valley (California). The first bite was received July 2, 1912. He experienced a sharp pain on the left arm and upon rolling up his sleeve discovered a large tick, partly engorged, attached to the upper arm in front. He dislodged the tick and sucked the lesion. The lesion when first discovered showed a small dark purple ring surrounding a bright red spot, the point of attachment. The discoloration disappeared in a short time but the arm was "highly irritable for two or three days and at the point of attachment a minute clear scab formed." The tick proved to be a pajaroello.

The second bite took place July 16 while seated in a thicket of willows (the first bite took place while riding over a brush grown hill), and in this case the sharp pain involved the left leg. An almost fully engorged tick, again a pajaroello, measuring about three-fourths of an inch in length and about one-half inch in width was removed from just above the shin. Once more a bright red spot was visible at the point of attachment surrounded by an irregular purple ring about three-fourths of an inch in diameter. In about half an hour the leg began to swell in the vicinity of the lesion and in about three hours the entire lower leg was tremendously swollen. The coloration about the point of attachment had widened considerably, was puffy and a clear lymph exuded from the lesion. The young man lanced the leg causing the blood to flow freely and treated the wound with crystals of potassium permanganate, binding the leg with cotton and gauze. During the following night he reports experiencing a general disagreeable feeling, the entire lower leg being "irritable and numb." On the following day the bite on the arm became irritable again, and was treated as had been the leg, fearing bad results. For several weeks both lesions exuded a clear lymph from beneath an "oily looking, transparent, red mottled scab, which remained in evidence for two or three months."

Chandler reported these ticks very numerous in some localities, having counted as high as six within half an hour crawling over a saddle blanket placed on the ground. Their presence and number seemed to be determined by the presence of cattle, although ticks were found where there were no cattle but in places which where evidently favorite haunts of wild animals.

EXPERIMENTS WITH THE PAJAROELLO

On monkeys: A number of specimens of *Ornithodorus coriaceus* were collected in the San Antone Valley and at Newman, California, for purposes of experimentation and study of life history. In coopera-

tion with Dr. W. A. Sawyer and Messrs. S. W. Newman and W. L. Chandler, the writer conducted a number of experiments particularly with reference to the bite. In one of these experiments a mature female tick was permitted to bite a nearly full grown monkey (*Macacus rhesus*) twice within an interval of sixteen days intervening between the two bites. The tick was applied at 9:42 a. m. Dec. 10, 1913, and began sucking blood at 9:43, one minute later, becoming engorged and falling off at 10:21 a. m., a period of 38 minutes. At 10:30, a few minutes after the tick dropped off, there appeared a deep red hemorrhagic area 2 mm. in diameter at the point of biting with a somewhat lighter area 10 mm. in diameter surrounding the central area. At 10:47 there was a black spot at the point of bite 1.5 mm. in diameter. the inner red hemorrhagic area measuring 4 mm., with a yellowish white area surrounding this 8 by 6 mm., and an outer petechial area 15 by 13 mm. No general symptoms were noted. The lesion reached its greatest expanse the following day when the following measurements were taken: dark purple spot 2 mm. in diameter (a very dark red scab); the inner red area 6 by 5 mm., the yellowish white area 20 by 12 mm., the outer area 48 by 23 mm. and fading. The yellowish white area including bite was slightly swollen. By December 14, i.e. four days after the bite was received, the ecchymosis had entirely disappeared; by December 16, six days after the bite, the lesion was entirely gone but for a slight pigmentation, a thickened reddish area measuring 5 by 3 mm. and a small scab 2 mm. in diameter.

The monkey remained normal throughout the experiment as regards temperature, weight, blood count and general condition.

The second bite was received by the same animal on December 26, the tick being applied at 9:43 a.m., taking hold at 9:44 a.m. and dropping off fully engorged at 9:55 a.m., requiring but 11 minutes to engorge. The history of the second bite follows that of the first very closely, except for the extent of the lesion which was greater, i.e. 70 by 30 mm. In order to note any manifestation on the part of the first lesion, the second bite was located near the opposite nipple. No change was observed. The lesion produced by the second bite had disappeared by December 31, i.e. five days after the bite, except for a slight thickening 3 mm. in diameter and a slight white scale at the center. Again the monkey had remained normal, except for a slight increase in the count of white blood corpuscles which rose from 7,400 at the time of the bite to 13,900 by noon of the same day, going down again to 7,300 by 5 p.m.

Both nymphs and adults readily attach to man, monkey, rabbit and mouse; and become fully engorged in from 15 to 30 minutes, depending on the number and length of rests in the rhythmic motion of the basis capituli. If dislodged while engorging, they, like the larvae, refuse to reattach immediately.

On rabbits: The bite on a rabbit's ear leaves a comparatively large, thick, purple nodule, and is accompanied by a more or less hemorrhagic condition of the entire ear tissue. The bite has no apparent systemic effect on the rabbit, and the lesion heals within two or three weeks.

On mouse: When a tick was applied to the body of a mouse for the first time, the mouse showed no apparent uneasiness until the tick attempted to withdraw its head. Beginning immediately after the tick dropped from the mouse there occurred a small swelling which exuded lymph, rapidly grew in proportions and was accompanied by marked ecchymosis. In 2 minutes after the tick had dislodged itself the swelling had increased its area 0.3 by 1 cm., in 30 minutes 0.5 by 2 cm., and in one hour 0.5 by 2.5 cm. After 24 hours the swelling had become reduced, except in the vicinity of the bite, and fully one half of the mouse was dark blue. But slight systemic disturbances were noticeable in the mouse, and it rapidly recovered. The same mouse was used as a host for other ticks, and each succeeding bite produced less and less noticeable results, until finally only very slight lesions were produced.

SUMMARY

The venomous Pajaroello Tick ("Pajahuello" according to Banks) is a native of Mexico, but is now known to occur in the more mountainous coastal counties of California as far north as Santa Clara within 100 miles of San Francisco.

The breeding habits, metamorphosis and life history have been carefully observed in the Parasitology Laboratory of the University of California. . Records of life history in individual cases (i. e., from egg to sexual maturity) show 159 days for the male and 343 days for the female at a temperature averaging 26.3 C. (variation $\pm$ 1 C.). The venomous nature of the bite as affecting man, monkey, rabbit, and mouse is described.

NOTE ON THE ETIOLOGY OF VERRUGA AS DEDUCED FROM A STUDY OF THE ASEXUAL STAGES OF BARTONELLA

Charles H. T. Townsend
Bureau of Entomology, U. S. Department of Agriculture

Dec. 4, 1915, the writer presented before the Biological Society of Washington a paper on the identification of the asexual stages of *Bartonella bacilliformis,* the causative organism of verruga, which was published in the Dec. 19, 1915, issue of the *Journal of the Washington Academy of Sciences.*

Jan. 7, 1916, he presented the same subject before Section VIII of the Second Pan-American Scientific Congress, during which presentation he announced certain points additional to those previously announced. This second paper will be published in due course in the Proceedings of the Congress, but it is desirable to place on record at once the additional points announced therein. They are as follows, and should be added to the paper published Dec. 19, 1915:

The toxin resulting from the extensive asexual multiplication of Bartonella in the vascular endothelial cells of the subcutaneous tissues is liberated in quantity into the blood, causing the rise of temperature which marks the fever stage of verruga, the anemia following through hemolysis.

The proliferation of vascular endothelial cells incited by this toxin not only imprisons the toxin itself, thus arresting the hemolysis, but also prevents the erythrocytes from coming into direct contact with endothelial cells containing merozoites of Bartonella, thus cutting short the infection of the erythrocytes. As the natural result, the fever and anemia both subside, and the gametes of Bartonella are no longer to be found in the peripheral blood.

The infected endothelial cell, in situ in the capillary wall, is positively chemotropic for uninfected freshly oxygenated erythrocytes, attracting and holding them in contact with itself until transfer of a certain number of merozoites of Bartonella has been effected, the presence of which reduces the oxygen tension in the substance of the erythrocytes, thereby transforming their tropic qualities, the sufficiently infected erythrocytes being set free through negative chemotropism.

The localized proliferation of vascular cells following verruga eruption-tissue inoculations is not due to any new activity of a living organism or virus. The reason why Drs. Strong *et al.* were unable to obtain proliferation lesions by injection of a filtrate from these tis-

sues is at once apparent; the proliferated vascular cells can not pass the filter. Their inoculation of these tissues upon the rabbit's cornea produced no lesion because the cornea possesses no vascular cells. Their attempts to cultivate the supposed virus in these tissues resulted in failure because the tissues evidently do not contain a living virus. (The term virus is used in the common acceptation of organisms that pass the filter.)

Drs. Strong *et al.* succeeded in demonstrating the presence in verruga eruption tissues of a hemolysin which is active in relatively high dilutions, and whose discovery is very much to the point in this particular connection. This hemolysin is quite certainly the toxic by-product of the reproductive activity of Bartonella in the subcutaneous tissues. It is the specific cause of the anemia of the fever stage of verruga. Further, it is the agent which directly incites the proliferation of the vascular cells, thereby causing the eruption lesions. In other words, this toxin is able to destroy such delicate structures as the erythrocytes; is able to irritate the more resistant vascular cells sufficiently to cause them to proliferate; but is unable to produce any effect on such highly resistant structures as the connective-tissue cells composing the cornea. Its proliferative action on vascular cells continues through many successive series of inoculations, but finally becomes attenuated and no longer effective.

In verruga cases, when the correspondence in intensity of fever and visible eruption is not well marked, it is practically certain that infection of the internal organs has become proportionately greater, resulting in an increased internal eruption.

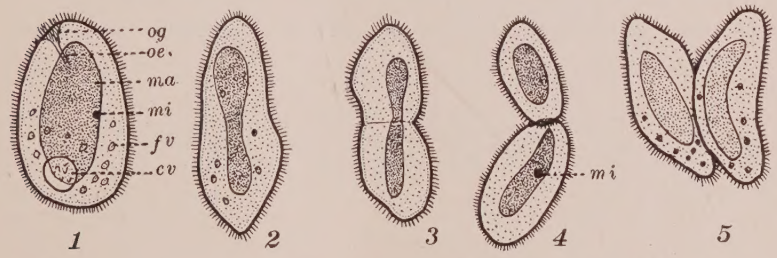
Notwithstanding all criticisms that may be put forward, the writer is content to rest his thesis upon the evidence presented, and invites a comparison of the published figures and descriptions of the vascular cell inclusions of the fever and eruptive stages of verruga. He has verified the findings by similar inclusions in his own verruga sections and smears. There are many additional details apparent at the present writing which have not yet been entered into, but they are unnecessary to the main demonstration; it is only necessary to say that all the details fit in perfectly with the identification that has been given of the asexual stages of Bartonella, thus clinching the interpretation of these as presented by the writer.

A NEW INFUSORIAN PARASITE IN SAND FLEAS*

MINNIE E. WATSON
Oyster Bay, Long Island, N. Y.

While examining some sand fleas on the shores of Long Island Sound for gregarine parasites, the writer found two hosts infected with an infusorian parasite; one of the hosts being the common small flea, *Orchestia agilis,* the other the larger *Talorchestia longicornis.* The two infected hosts were found in the same habitat and on the same day. The infusoria were found in only these two instances out of about 300 fleas examined for gregarines. The parasites infect the alimentary tract of the host in great numbers, several hundred being present in each flea.

In the vegetative stage, the animals are broadly ovoidal, tapering slightly at one end (Fig. 1). The macronucleus is very large, and ellipsoidal in shape; it is granular and homogeneous and does not



EXPLANATION OF FIGURE

1. *Balantidium orchestium,* vegetative individual. *Og,* oral groove; *oe,* esophagus; *ma,* macronucleus; *mi,* micronucleus; *fv,* food vacuole; *cv,* contractile vacuole.
2, 3, 4. Three stages in binary fission.
5. Conjugation.

stain deeply with Ehrlich's hematoxylin and acetocarmin. The micronucleus is small and deep staining, and lies contiguous to the macronucleus. The apical or subapical oral groove is small and inconspicuous; it leads to a short slender esophagus. Small contractile vacuoles were observed, not more than one being seen in a single individual. Many small food vacuoles were often present. Cilia of uniform length

* Contributions from the Zoological Laboratory of the University of Illinois, under the direction of Henry B. Ward, No. 61. Also from the Biological Laboratory, Cold Spring Harbor.

cover the body, those in the oral groove being slightly the longer. The size of vegetative forms ranges from 300 to 360 microns by 180 to 220 microns.

In individuals which are ready for asexual reproduction, the body becomes elongate and tapers at the ends; the macronucleus becomes longer and constricted centrally, at the same time contracting in volume. It also stains more deeply than does that of the vegetative animal (Figs. 2, 3, and 4). When transverse fission is complete, the two nuclei attain their normal vegetative form and density. Conjugation was noted in one instance.

The parasite may be classified as follows:

1. Order Heterotricha: zone of large cilia leading to mouth.
2. Suborder Polytricha: body covered with an even coat of cilia.
3. Family Bursaridae: peristome broad, body broad and large.
4. Genus Balantidium: parasitic, inhabiting the alimentary tract of the host, body ovoidal or ellipsoidal, blunt at ends in vegetative stage, macronucleus ellipsoidal.
5. The parasite is closely allied to *B. coli* Stein and *B. elongatum* Stein; it differs from them in size of the body and in relative size of the nucleus. No previous record of this form has been found.

I wish therefore to designate this species *Balantidium orchestium.*

Urbana, Ill., June, 1915.

References Cited

Doflein, F. 1911. Lehrbuch der Protozoenkunde. Jena, 1043 pp.

Minchin, E. A. 1912. An Introduction to the Study of the Protozoa. London, 520 pp.

BOOK REVIEWS

REPORT OF FIRST EXPEDITION TO SOUTH AMERICA. Harvard School of Tropical Medicine. Richard P. Strong, Ernest E. Tyzzer, Charles T. Brues, A. W. Sellards, J. C. Gastiaburu. Cambridge. Harvard University Press, 1915. 220 pages. 48 plates.

This very excellent report deals with the investigations of the first expedition sent out by the Harvard School of Tropical Medicine, to study certain forms of tropical disease occurring in South America. The report treats of the sanitary conditions of the places visited, namely, Kingston, Jamaica, Colon, Panama, Buenaventura, Guyaquil, Callao, Lima, and certain mountain towns in the interior of Peru.

While at Guayaquil yellow fever was very prevalent and many cases of this disease were studied. Especial attention was paid to the study of the blood, owing to the reports of Seidlin regarding the presence of a protozoon which he has named *Paraplasma flavigenum* and which he regards as the cause of the disease. As a result of their investigation of the blood in yellow fever, these investigators say: "We were unable, however, to detect any bodies which suggested a parasitic nature in the blood in this disease."

The larger portion of the report deals with the investigations of oroya fever and verruga peruviana and as the results of their investigations the authors have determined, apparently without question, that these conditions are distinct diseases. Verruga peruviana is due to a virus which may be transmitted to animals by direct inoculation, the nature of which is still unknown, while oroya fever is due to a parasite of the red blood corpuscle, which cannot be transmitted to animals. The parasite concerned in the etiology of this disease is of interest to protozoologists because it apparently belongs to a new genus which Strong has called *Bartonella*, naming the genus after Barton, who in 1905 first described the bodies within the red corpuscles. The specific organism causing oroya fever has been named *Bartonella bacilliformis*. Multiple infection of the red cells is common in severe infections, as many as ten of the parasites being present in one cell. Morphologically the parasites occur in the form of minute rods resembling a bacillus, measuring from 1 to 2 microns in length and rounded or oval forms, measuring from 0.3 to 1 micron in diameter. Both rods and rounded forms contain, in stained preparations, granules which may be interpreted as chromatin. The investigators were unable to infect either monkeys or rabbits with this parasite.

While unable to find any parasite in the cases of verruga peruviana studied, the authors were able to produce very typical lesions in both monkeys and rabbits, thus demonstrating the distinct nature of the two diseases. They were unable to definitely decide whether the virus of verruga is filterable, but believe that ultimately it will be shown to be so. As regards the transmission of the two diseases the authors were unable to determine in what manner this occurred but lean to the opinion that some arthropod is concerned.

Uta, a disease of the skin, occurring in Peru, was also studied and the authors were able to demonstrate that this disease is due to a species of *Leishmania*. As regards the species they say: "For the present at least, from the evidence available we do not feel justified in creating a new species for the parasite discovered by us as the etiological factor of uta." A wise decision in view of the present unsatisfactory classification of the Leishmanias.

The report also contains a description of a new Linguatulid parasitic in the crocodile, in Equador, which Wheeler has named *Poracephalus crocodili;* a discussion by Brues of the flies of the family Phoridea obtained by the expedition, and some notes on Peruvian mosquitoes and mosquito literature, by Knab.

The book is beautifully printed and illustrated and forms an excellent example of the good work that may be accomplished by medical expeditions. The authors are to be congratulated on the success of their labors for they have contributed a most interesting and valuable addition to the literature and knowledge of tropical medicine.

MEDICAL ZOOLOGY IN BRAZIL.—At present marked attention is being paid to parasitology as is evidenced by recent publications noteworthy in form and character. This movement has found its expression both in monographic articles accorded a place in general medical literature and in a special periodical devoted to the subject. Brief comments on these items will be of service to North American parasitologists who may not have seen the original publications as yet.

Archivos Brasileiros de Medecina (Anno iv, nos. 1, 2, 3) contains an extended discussion of hookworm and hookworm disease covering seventeen separate contributions on all phases of the subject, illustrated by nine full-page plates. The work is complete and scholarly in treatment, giving much that is not available elsewhere. Of especial value is the critical bibliography on ancylostomiasis in Brazil.

Memorias do Instituto Oswaldo Cruz, published at Rio de Janeiro, which reached its seventh volume in 1915, includes original articles on protozoology, helminthology, and medical zoology generally. The text is usually printed in Portuguese and French or German in parallel columns. The journal is illustrated by full page plates in heliotype and lithography in colors, which are very sucessful and deserve high praise. Most articles concern those elements of the fauna of Brazil which are related to the cause and dissemination of disease. A recent number contains also a sketch of Professor von Prowazek accompanied by a fine portrait.

ARCHIVES DE PARASITOLOGY.—Publiées par Raphael Blanchard, Professeur à la Faculté de Médecine de Paris, Member de l'Académie de Médecine.

Les Archives de Parasitologie, imprimees à Lille (Nord), ont dû suspendre leur publication, par suite de l'occupation de la ville de Lille par les armées allemandes.

Le fascicule du tome XVI porte la date du 1st août 1914. Il était remis au chemin de fer, quand le guerre a éclaté. Il a dû être retiré et, dupuis lors, n' a pu être distribué.

Voici son sommaire:

P. S. de MAGALHAES, Notes d'helminthologie brésilienne, dixième série (avec 7 figures dans le texte), page 481.

R. BLANCHARD, Notices biographiques, XXIV. Louis-Daniel BEAUPERTHUY, 1807-1871 (avec 2 figures et 7 fac-simile dans le texte), 503.

G. R. BLANC, Sur quelques espèces du genre *Diplotriæna* Railliet et Henry (avec 10 fig. dans le texte), 546.

P. MOLA, Cestodes Avium. Contributo alla fauna elmintologica sarda (pl IX), 557.

Les Parasites et les maladies parasitaires dans l'historie, la poésie et l'art, 579-637.

Notes et Informations, 638.

Table des matières, 639-640.

Le premier fascicule du tome XVII était en bonne voie d'impression; les cinq premières feuilles étaient déja tirées, au moment de la déclaration de guerre.

Les *Archives* ne pourront reprendre leur publication régulière qu'après la cessation des hostilités. Elles paraitront alors par fascicules moins gros et plus rapprochés.